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DIACK'S EXCAVATOR FOR SINKING CYLINDER FOUNDATIONS.

By J. Diack, Tokio, Japan.

In the summer of 1875 I had to sink a number of brick cylinders, 12ft. in diameter, for the foundations of a large railway bridge and other works, through coarse gravel, hard and compact enough to carry the Victoria Tower; and for the purpose I had placed at my disposal several Milroy's excavators, Kennard's sand pumps, and Bull's hand dredgers. But these machines, however well adapted for softer strata, were found entirely unsuitable.

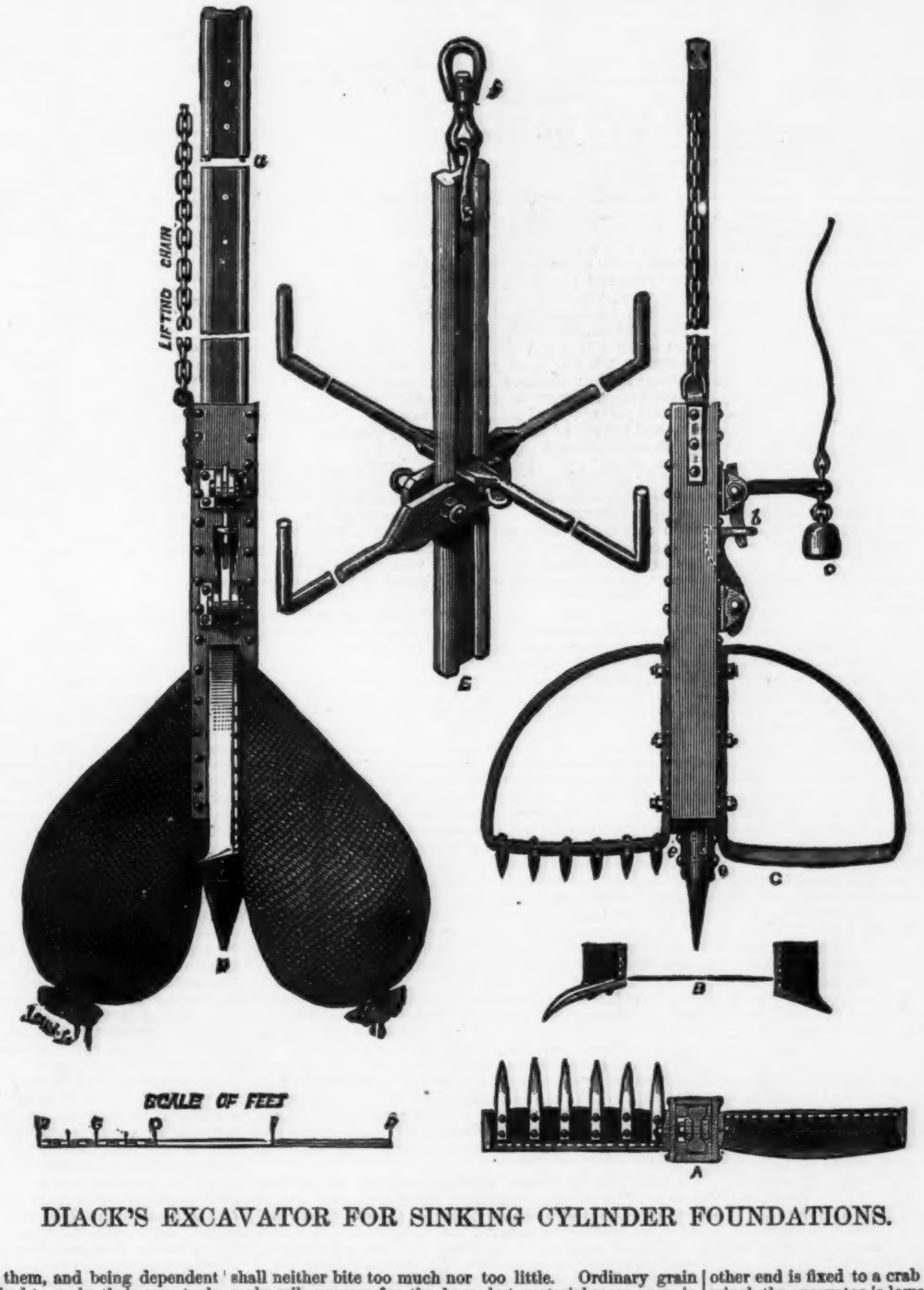
As resident engineer of the works it devolved upon me to devise some means of executing them, and being dependent upon Japanese workmen—who had to make their own tools from native steel ore to begin with—it was desirable that whatever was to be designed should be of simple construction; and the sketch I now send you, although more elaborate, is only an improved form of the excavator then made, which cost but little either to manufacture or keep in repair, and was found to be both certain and economical in its action. During months of working it never once came up without a load, and the staging required for its working was of the most inexpensive nature. After the interior was excavated, in all cases the cylinder stood upon the strata as on a wall, and it was necessary to send divers down to pick the gravel from underneath the curb. (For illustration of this excavator see page 291).

The teeth, which are $\frac{7}{8}$in. diameter, and the dowels in the joints of the shaft, shown at *a*, are of steel; the remainder is of iron. The dredging rings are made from bars $3\frac{1}{2}$ in. by $\frac{5}{8}$ in. The shaft is of rails fished together in the usual way, but with the bolt heads countersunk into the fish-plates. The sliding-socket is of bar iron, riveted together, with pieces in the angles for clearance of the fish-plates and bolts. An extra fish-plate is fixed to the web of the rail, the lower end of which rests upon the catch *b* while the excavator is at work. When the shaft is suspended and the excavator is resting upon the two brackets *e e*, there should be an inch of play room between the lower end of the extra fish-plate and the top of the catch *b*.

The relative height at which the two dredging rings are fixed is a matter which requires attention, so that the teeth shall neither bite too much nor too little. Ordinary grain sacks will answer for the bags, but material more open in texture is preferable. The bags are sewn on inside the dredging rings, through the small holes shown on the sketch; in the line of those holes, both inside and outside the ring, a hollow grove is hammered into the iron, and after the bags are fixed a piece of hoop iron is riveted on the edge of the canvas to prevent abrasion; the cords for tying the bags are passed through small rings sewn on outside. A is a horizontal section through the excavator. B shows the relative height and form of the bottom of the dredging rings and teeth. C shows the excavator with the bags removed; *b* is a catch which falls into its place by the gravity of the weight *c*, and is disengaged by pulling the cord attached. D is the excavator when full and slightly raised to relieve the catch *b* (in the view D, the weight and cord are both removed to show the form of the catch); E shows the form and mode of attaching levers for turning the excavator.

The mode of working is as follows:—Two single-sheaved blocks are fixed adjoining each other directly over the centre of the cylinder to be sunk, and, say 20 ft. to 25 ft. above the stage upon which the men work who are engaged at the excavator, a third single block is fixed in any convenient position so as to be cut of the way. A rope is passed through one of the first-named blocks, thence through the last-named one. One end of the rope is fixed to the swivel *f*, the other end is weighted to counterbalance the surplus weight of the shaft, leaving only sufficient to load the excavator. Another rope is passed through the remaining block, one end of which is attached by a spring hook to a lifting chain, the other end is fixed to a crab winch. By means of the crab winch the excavator is lowered to the bottom of its shaft, the spring hook detached from the chain and attached to the swivel *f*, the chain is lashed to one of the levers to prevent its fouling, the shaft of the excavator is raised a few inches to allow the catch *b* to fall into its place, and then lowered ready for work. The men at the levers proceed to turn the excavator. If a firmly imbedded stone, say 4 in. to 9 in. in diameter, is met with, the excavator will probably stick; the men at the levers hold the excavator tight against the obstacle, while the men at the crab winch raise the excavator: if a stone of the former size, it will probably rise from its bed at once, if of the latter size it may have to be attacked several times before the teeth get suffcient hold.

When the bags are supposed to be full, the excavator—and shaft—is raised clear of the bottom, the ropes, if twisted, allowed to uncoil, the catch disengaged and the cord held



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tight, the excavator again lowered, the spring hook detached from the swivel and attached to the lifting chain, the excavator raised to the stage, emptied on to a trolley or small sliding stage, and is ready for lowering again. If sand or other soft strata require to be worked, the toothed ring is detached and a plain one substituted.—*Engineer.*

HARDENING AND TEMPERING STEEL.

By JOSHUA ROSE, M. E.

No. 2.

IF we heat a piece of cast steel to redness and plunge it into clean water until its temperature is reduced to that of the water, the result will be that the steel will be hardened. The degree of the hardness will depend upon the quality of the steel, the temperature to which it was heated, and to a small degree upon the temperature of the water in which it was cooled. In any event the operation will be termed that of hardening. If we reheat the steel a softening process will accompany the increasing temperature, until upon becoming again red hot it will assume its normal softness, and if allowed to cool in the atmosphere the effects of the first hardening will remain entirely removed. If, however, after the steel is hardened, we polish one of its surfaces and slowly reheat it, that surface will assume various colors, beginning with a pale yellow and ending in a blue, with a green tinge, each color appearing when the steel has attained a definite degree of temperature; hence by the appearance of the colors we are informed of the temperature of the steel, or in other words, how far, or to what extent, the resoftening has progressed. This chemical fact is taken advantage of by the machinist to obtain in steel any required degree of hardness less than that of the absolute hardness obtained by hardening, and is termed tempering. The temperatures at which these respective colors will appear are as follows:

Very pale yellow	430° Fahr.
Straw yellow	460° "
Brown yellow	500° "
Light purple	530° "
Dark purple	550° "
Clear blue	570° "
Pale blue	610° "
Blue tinged with green	630° "

To say, then, that a piece of steel has been tempered to a straw color, implies that it was first hardened and then reheated until the straw yellow appeared upon it, the temperature having arrived at 460° Fahr., and that the reheating process was then discontinued. The presence of the straw color, however, while evidence of temperature to which the heating took place, is no indication of the actual degree of hardness of the steel, because that depends upon the degree to which the steel was hardened before the color test tempering was resorted to. And since the degree of the first hardening depended upon the quality of the steel, the degree to which it was heated, and the temperature of the water in which it was cooled, it follows that the above quality, heating, and temperature must be uniform in all cases if uniform results are to be reached.

The higher the grade of steel, the lower the temperature at which it will harden, and the harder it will be it cooled in water from a given temperature; but any degree of hardness obtained from a temperature equal or less than the highest at which a color would appear, that is 430° Fahr., will obviously be representable under the color process by a color, providing, of course, that the steel was first thoroughly hardened.

Now it is manifestly desirable to obtain any required degree of hardness by a single process if possible; and hence by heating a known quality of steel to a definite temperature, and quenching it in water or other liquid or mixtures maintained at about an even temperature, the color test is becoming, in some cases, dispensed with, the conditions of heating and cooling being varied to give any degree of hardness from the highest attainable down to normal softness. Another and very desirable method of hardening and tempering is to heat in a flue of some kind maintained at the required temperature over the fire, and cool either in water or a quenching or cooling liquid, and then, instead of employing the color test, to provide a tempering bath composed of some substance that will heat, in the open air, to a temperature of about 450.° By placing the articles (after hardening them) in the tempering bath and heating it to a temperature equal to the color of temper (under the color test) required, we have but to cease supplying heat to the tempering bath when a thermometer standing therein marks the required temperature, and a uniform degree of temper will be given to all the articles, and the operation will occupy much less time than would tempering either individually or collectively by the color test, because a liquid is much more easily kept at an equal temperature throughout its mass than are the heated sand, hot pieces of iron, or iron tubes resorted to in tempering by the color test. Another method of tempering which if capable of reduction to uniformity would be the quickest and hence most desirable of any is to heat the steel to a definite temperature, and cool or quench it in a liquid having sufficient greasiness or other quality which acts to retard its retraction of the heat from the steel, and thus give a temper at one operation. As an example of this kind of tempering it may be mentioned that milk and water, mixed in proportions determined by experiment upon the steel for which it was employed, has been found to give an excellent spring temper. Nor is there any doubt but that, carefully conducted, such tempering may be of the very best quality. A great deal, however, in this case depends upon the judgment of the operator, because very little variation in heating the steel or in the proportions of milk to water produces a wide variation in the degree of temper. If on trial the temper is too soft the steel may be made hotter or there may be more water added to the milk. If the steel was heated as hot as practicable without increasing the danger of burning it, more water must be added, while if the steel was made red hot without being hot enough to cause the formation of clearly perceptible scale the steel may be heated more. It is desirable, in all cases, but especially with a high grade of steel, to heat the steel not above a blood red heat, although shear and spring steel may be and often must be made hotter, in order to cause it to harden when quenched in water. In former times the hardening by fire and water and tempering by the color test were exclusively employed for hardening and tempering, except in cases where elasticity was the property sought to be imparted to the steel, and in this case a process termed blazing off (which will hereafter be treated of) was substituted for the color test, and in those days the term *hardening* was understood to denote the process of heating to a cherry red and cooling in cold water; this was sometimes further defined if either of the terms "giving the steel all the water" or "hardened right out" were used to particularly specify that the steel was not to be extracted until reduced to the temperature of the water. The necessity for these terms arose from a practice, that sometimes obtained, of withdrawing the steel from the water before it was quite cold, and many excellent hardeners and temperers there are, who, at the present day, withdraw the steel from the water when it has sufficient heat left in it to rapidly dry off the water adhering to it, the result being, it is claimed, to alter the degree of hardness to a practically imperceptible degree but to add considerably to the strength of the hardened steel.

In those days tempering was understood to mean the second process, whose object was to modify, to a definite degree, by the color tests, the effects of the first hardening. Since the introduction of the other methods of hardening and tempering above referred to, the terms hardening and tempering have come to be used by many persons indiscriminately, and it is a fairly debateable question what process should be termed hardening and what tempering. First, then, any degree of hardness less than that obtainable in a given quality of steel, heated to the brightest degree without causing the chemical change known to smiths as "burning the steel" to set in, must be a degree of temper, notwithstanding that it would have no representative color under the color test, because it is a degree of hardness less than the maximum.

In practice a toolsmith usually heats cast steel to what he terms a cherry red; anybody, however, who has watched an ordinary blacksmith heating tools to harden will have observed that "cherry red" practically includes all ranges of temperature between blood red and a red verging upon deep yellow, the blacksmith being perfectly satisfied so long as the steel was not burned. The difference in the hardness obtainable by these two extremes of heating is not of practical importance in steels of fine grade; but in steels of inferior grade, as some grades of spring and shear steel, it is so great that a blood red will not appreciably harden, while a yellow red will harden beyond the highest degree attainable under a color test. The question arises, then, shall a piece of steel possessing any of the degrees of hardness laying between that denoted by a yellow under the color gauge and the highest attainable by giving the steel a maximum of heat (short of burning the steel) and "all the water," be termed hardened or tempered? Now of these degrees of hardness we have no clear conception, having no practical means of gauging it. If we give to a machinist a tool of a particular shape, he has such a clear idea of the hardness and strength it will possess when tempered to a color, that he can determine how hard it can be made to perform a given duty or about to what color it must be made to leave it strong enough to withstand the strain due to a given duty. Or if we give him a piece of steel soft at one end and hard at the other end, the graduation proceeding uniformly from end to end, he can take a file and, after testing the hardness, mark upon the steel with tolerable accuracy the sections corresponding in hardness to a blue, a purple, a brown, and a straw color, and would know of what hardness to make a tool that would cut the steel at any particular section not too hard to entirely resist cutting. This knowledge he has obtained from manipulations performed upon steel of all degrees of color temper; but if we were to give him a piece of steel harder than any degree denoted by a color and yet not of maximum hardness, he would be dealing with an utterly unknown quantity.

"Tempering," applied to define the degrees of hardness denoted by the shades of color ranging between the palest yellow and the deepest blue, conveys (in connection with a color as, say, tempered to a straw color) a clear idea of a definite and recognizable degree of hardness; but made to include a greater degree of hardness than is denotable under the color test, it would cover in its meaning a number of unknown quantities which seriously impair if not even destroy its whole value.

From this it appears that the word *tempered* (as applied to steel) should properly apply to all degrees of hardness denotable by color in the color test, and that "hardened" should include all degrees of hardness above that denoted by the palest yellow on the color test. Under this interpretation the meaning of the word will be extended to include all single processes which give degrees of hardness denotable by colors, hence the original meaning will be preserved to that extent. On the other hand, however, there is little doubt that the word was originally applied to the process because that process *tempered* or *modified* the degree of hardness of the steel, as indeed is proved by the fact that it was and is very often used interchangeably with the term *lowered*; thus, to *lower* to a blue was and is to temper to a blue; this is further attested by an old expression which is still in common use, viz., to draw the temper, thus, *drawn* to a blue implies that a piece of steel, "hardened right out" or "given all the water," has had its hardness reduced, or drawn, to the degree denoted by a blue color.

We have however another consideration, in that steel given a definite degree of temper (corresponding to a color under the color test) by a single heating and quenching process has not been *tempered* in the sense that it has been lowered or suffered a reduction of hardness; on the contrary, it has received an increased degree of hardness. We may indeed stretch a point and claim that it has suffered a reduction of softness, but then *temper* is understood to mean, directly, a degree of hardness, because normal softness is in practice understood to be the condition as regards softness in which steel is supplied by the manufacturers. If from this condition it is rendered softer by softening processes, that is termed softening, while all degrees of hardness above that must come under the head of either hardened or tempered.

We have then to choose between including in the term "tempered" all processes which act to reduce the hardness of the steel to a degree recognizable under the color test by a color, or to confine its meaning to all processes by which the degree of hardness is modified, lowered, tempered or lessened; and in view of the fact that the result reached and the object sought in either case is to obtain a definite degree of hardness comparable to that obtained under the color test, the former interpretation is undoubtedly the best. In any event it is an error to apply the term *tempered* to processes which, at one operation, leave the steel harder than any degree answerable to a color in the color test; while it has been shown that a process which reduces the hardness of the steel without bringing it down to a degree denoted by a color in the color test should be termed hardening.

This matter would be considerably simplified if, instead of the color, the degrees of temperature were specified; thus tempered to 460°, would mean the same degree of hardness as a straw color, and all the degrees of hardness above that would be specified in less degrees of temperature, and all degrees of softness down to a blue with a green tinge would be included in ranges of temperature up to 630°. The degrees of softness below that, being indistinguishable by either a color test or any other known indication save the ease with which it can be cut, would still remain unknown quantities or degrees. This plan would remove another technical objection to the color test, which is that the presence of a color obtained on a piece of steel by subjecting it to heat is no evidence that the steel possesses any above its normal degree of hardness; for steel, wrought iron, or even cast iron that has been softened to the lowest degree, will assume, on a polished surface, all the colors, providing that they are heated to the necessary temperature; hence the presence of color is simply proof that the steel has been heated to a certain temperature, but by no means proof that it possesses temper, or indeed that the process of heating has in any way modified the degree of hardness or softness.

Tempering, when performed by a second operation, reducing the hardness obtained by a previous one, is dependent for its uniformity upon the uniformity of the first one; hence if a number of pieces of steel of the same grade be heated to an equal temperature and plunged in water until cooled, and are subsequently tempered to the same shade of color, they will all possess an equal degree of hardness; but if other pieces of steel of a different quality or grade (this may be further specified by saying "containing a different percentage of carbon") be subjected to precisely the same processes, leaving upon them the same temper color. While this latter batch will be uniform in hardness, it will not possess the same degree of hardness as the pieces of the first batch, hence temper color may be used as proof of equality in the degree of temper in pieces of the same steel, but is not indicative of any determinate and uniform degree of hardness. In tool hardening, this fact assumes but little practicable difference, because for tools a special quality of steel termed tool steel is supplied, which will harden sufficiently to give accuracy to the color test tempering, when heated to any degree of heat answerable to from a blood red to a yellow red, the difference of hardness in steel quenched, from either of these degrees of heat, being too small to be of practical moment in all tools comparatively inexpensive to make. In tools that *are* expensive, it is desirable to give the exact degree of temper which experiment has determined as the best. It will be noted that in the color test the shades of yellow alone extend over a range of 70° of temperature, and tool users know that within these 70° lies a wide range of hardness. It is better, then, to adopt a tempering process that will determine with approximate accuracy the first heating temperature, such for example as by heating the article in some flux such as melted lead, melted salt, or melted glass, plunging it into a cooling mixture or liquid whose temperature can be maintained, by suitable means, somewhat equable, and drawing the temper in a bath maintained at the required thermometrical temperature. By this means, the steel used being a brand known for its uniformity, both the hardening and the tempering will have the greatest practically obtainable degree of temper, and the tools will be hardened more answerably to the requirements of the duty than is obtainable under the color test. This plan is indeed largely resorted to when large numbers of pieces require tempering; but if the articles are large or tempering requires to be done piecemeal and at odd times, it will not pay, as a rule, to keep heating and tempering mixtures constantly ready upon the fire, and the open fire and color gauge must be resorted to. It is under these latter conditions that the whole of the skill of the hardener and temperer is called into play, since, from the moment the steel is placed in the fire until it is cooled, all through to the temperature of the water, judgment and expertness are qualities absolutely essential to entire success.

SEA SOUNDING.

SIR WILLIAM THOMSON has for several years past devoted himself to the improvement of means and methods of navigation. His special experiences on submarine cable-laying expeditions have doubtless turned his efforts in this direction. The subject is one of deep human interest and vast commercial importance, and we regard it as a fortunate circumstance that he has taken it up. The uncertainties of navigation, the risks of life and property at sea, are every now and again painfully impressed upon all by some dreadful calamity, and he who, by some improvement in apparatus or method of observation successfully diminishes this risk, confers an incalculable boon on the public at large. Sir William has brought to the subject a familiar practical and theoretical acquaintance with the current systems of navigation, and in addition to this, the rarer advantage of a wide and deep knowledge of physical science. With these materials at the command of an inventive genius such as his, we may expect from him some far-pushed advances of the first importance. We are already indebted to him for the revival of Sumner's method of finding a ship's position, for the application of the Morse telegraphic code of signals to lighthouses, whereby a lighthouse is made to flash its own distinctive letters, for the patent adjustable compass, and for the patent sounding machine we are about to describe. The compass is remarkable for its steadiness under the oscillations of the ship, the heeling error is overcome, and deviation on all courses whatever is either entirely annihilated or reduced to a fraction of a point. It is earning for itself golden opinions in all waters.

The object of Sir William Thomson's patent sounding machine is to facilitate the measurement of the depth of water below a ship at any time without reducing the speed; it is, in fact, designed to take flying soundings. We have already given an account of his apparatus for sounding by means of pianoforte wire; but the present apparatus, although employing the wire, is based on a distinct invention. The wire-sounding apparatus formerly described proves highly serviceable for sea-deep soundings when the ship is slowed or at rest; but the present invention permits of flying soundings being made with a great accuracy. The sounding machine as now patented is an improved and more complete form of the other. It is especially useful when approaching land.

The essential idea of the new invention is to measure the depth by the pressure of the sea water at that depth. This is effected by lowering a pressure gauge with the lead line. Two forms of this pressure gauge are patented. The first, and that chiefly in use, consists of a narrow glass tube closed at one end and open at the other. It therefore contains a column of air. But when it is lowered into the sea the water entering the open end of the tube compresses this air column, diminishing its length in proportion as the water pressure increases, according to Boyle's well known law. The height to which the sea-water rises in the gauge tube marks

the limit to which the air has been compressed. Means are therefore taken to cause the water to indicate the height to which it rose in the tube. One plan is to line the interior of the tube with a preparation that shall mark the distance that liquid has been forced into it. This preparation may be whitewash or size color, or ink, or aniline blue, dried upon the inside of the tube, or it may be a substance such as red prussiate of potash, adapted to show by chemical discoloration how far the liquid has been forced up. These substances may be made to adhere directly to the glass, or a strip of paper impregnated with them may be gummed along the interior of the tube. Another plan is to tincture the sea-water itself as it enters the tube with ink, aniline blue, sulphate of iron solution, or any other liquid suitable for leaving its mark. For this purpose the marking liquid is contained in a cup or thimble at the lower or open end of the tube. In order to prevent the marking liquid from running up the interior by capillary attraction the whole interior of the tube is coated with shellac, varnish, glue, or gum, dried upon it before attaching the lining prepared to receive the mark. Sulphate of iron, besides being very inexpensive, gives a sharp and strong mark when a strip of paper impregnated with red prussiate of potash is used, or when the prussiate of potash mixed with starch is applied directly to the inside of the tube. Sir William has, however, quite recently substituted chromate of silver for red prussiate of potash, in the lining of the tube, with great advantage, as the sea-water alone makes a sufficient mark, altering the chromate of silver from a reddish orange color to white.

The tube must be of so narrow a bore that there shall be no splashing of the liquid in it during the sounding process. The glass tube is guarded from shocks by an outer metal tube, preferably of brass, which permits access of the water to the glass tube it protects, by holes in the upper end. This guard tube is shown at *c* in the figure.

end of the wire. The clockwork indicator I registers the number of fathoms of wire paid out, and is worked by the axle of the drum.

Another essential novelty in this machine is the friction brake. It will be readily understood from the diagram. The weight E is centered at N, and at its other end at D a rope M is fastened. This rope M is made to take a single turn round a deep groove in the periphery of the drum B, as shown by dotted lines. M then passes over the pulley G, and is belayed to a pin F fixed to the pulley itself. H is an adjustable weight also fixed or carried by the pulley G, and from its horizontal position at *c* it can be raised to the positions indicated by the dotted lines at *b* and *a*. When it is in the position shown, E is at its highest position against the stop K, the maximum stress is on the rope, and consequently the maximum friction is on the drum, because both weights, E and H, pull on the ends of the rope with their maximum effect. When H is at the position *b*, the weight E hangs intermediate between the upper stop and the base A, and the pull on the rope is about 7 lb., which corresponds to a frictional resistance on the drum of about 5 lb. When H is in the position *a*, its weight is directly over the axle, and E rests on the stand. The friction on the drum is then almost entirely removed.

In order to take a cast the sinker is armed with tallow, which should also be well smeared all over the lower end of the sinker in order the better to secure a good specimen of the bottom. One of the prepared glass gauge tubes, with its open end downwards, is placed inside the brass guard tubes. The sinker and tube are then gently lowered to the surface of the water, the drum being held back till the indicator is set and the weight H is brought into the position *b*, which corresponds to a retarding friction on the drum of about 5 lb. All is now ready, and the drum is let go. It revolves rapidly under the pull of the sinker, notwithstanding the opposition of the brake, and the wire runs quickly out.

SIR WILLIAM THOMSON'S SELF-INDICATING SOUNDING INSTRUMENT.

When it is desirable to obviate the necessity of previous chemical or other preparation of the tube, a special tube, which is made to retain the column of water inside, is employed. It is provided at each end with a mounting containing a valve which opens inward under a definite amount of force. As the tube descends into the sea the lower valve is forced open, and the water enters the tube, at the same time compressing the air in its upper part. When the bottom is reached and hauling in is commenced, so that the tube is caused to move through the water upward, the lower valve shuts and holds the water which had entered by it, whilst the tube was being sunk. On the other hand, the pressure of the sea, acting upon the upper valves, causes it to open, thus allowing the air within the tube gradually to escape as the tube nears the surface, but at the same time allowing no water to enter. Thus, the pressure of the air inside the tube is kept constantly balanced by the pressure of the sea outside the tube, so that there is no danger of the bursting by pressure of the contained air as it rises to depths of less external pressure. This tube is also protected by a metal casing.

In order to ascertain the depth to which the tube has been sunk, a scale or "rule" is provided. It is graduated in single fathoms up to 100, and is applied to the tube immediately it has been brought to the surface. In the chemical tube the length of coating which has been discolored, and in the valved tube the height of the column of water restrained inside, gives the number of fathoms depth. The scale of the valved tube is marked on the edge of a slit cut along the casing on one side, so that the depth can be read off directly.

The tube is used with the wire-sounding apparatus, of which the accompanying engraving represents the most improved form. The wooden stand A of the machine is lashed or bolted to the taffrail at the stern of the vessel, or to a platform firmly fixed to support it, so that it projects from the ship's side, and the sinker S, when ready for a cast, hangs direct from the wheel or drum B, clear of everything over the water. The steel pianoforte wire is coiled on the drum B, which is of iron, light, but strong. The sinker is a cylindrical iron weight 3 ft. 3 in. long, weighing about 22 lbs., with a hollow in its lower end to receive the usual arming of tallow. It is attached to the end of the wire by an intermediate piece of rope about 9 ft. long. The gauge tube is lashed to this rope, as shown in the drawing, about 3 ft from the metal ring, by which the rope is attached to the

When, however, the sinker strikes the bottom, the brake power speedily stops the drum. When it is seen to stop, the weight H is allowed to fall to the position *c*, whereby the full power of the brake is applied to the drum to prevent any more wire from running out. The handles are then applied to the drum and winding in is begun. The first effect of this is to raise the weight H to its highest position, whereby the retarding friction of the brake cord against the motion of the drum in turning it, is almost entirely taken away, and only the resistance of the wire and sinker is experienced.

As soon as the wire is wound in, the tube is taken out of its case and the height of the water line measured by scale. This without correction is the depth accurately enough, if the barometer be at anything from 28¾ inches to 29¼ inches. If the barometer stand at 30 inches it is necessary to add one fathom in thirty to the reading, and if it stand at 31 inches one fathom in fifteen.

In order to preserve the wire from rusting, the drum when not in use is taken off its bearings and immersed in a bath of caustic soda or quick lime. The wire is also either dried by hand as it is hauled in, or passed over a rubber soaked in the caustic solution. In sounding during very cold weather, when water brought up by the wi e is liable to freeze on the drum provision is made for filling the drum which is hollow, with hot water in order to thaw it before use.

"When navigating out of the sight of land," says Sir William Thomson, "in less than 100 fathoms, if there is any doubt as to the ship's position, whether from the sky not being clear enough for sights, or for the errors of the chronometers not being known with sufficient certainty, the sounding machine should be kept going. Two men suffice to work it, whatever be the speed of the ship. It takes from a quarter of a minute to a minute for the sinker to reach the bottom from the time it is let go, and from a minute to four minutes for two men to haul it in, if the depth is from 30 to 100 fathoms. (One man can haul it in though the ship be running at 16 knots, but not quite so quickly nor so uniformly as two). Thus it is easy to take a sounding every six or eight minutes, with an extra hand or two to relieve. Two men can with ease take a sounding every quarter of an hour, and this should be the rule whenever in keeping the machine thus going useful information as to the ship's place can be had. It is not necessary to use a tube every time. The reading shown on the counter (indicator) at the moment the sinker strikes the bottom allows you to judge the depth surely and accurately enough if you use a tube occasionally. The reading on the counter shows approximately the number of fathoms of wire run out. This may be something nearly twice the depth, but the proportion of wire to depth differs according to the depth, the speed of the ship, and the roughness of the sea. For the first of a set of casts use a tube, and read off the depth accurately by applying it to the scale of fathoms. After three or four more casts use another tube, and then, according to judgment, use a tube as frequently as necessary to check your inferences of depths from the counter readings. The character of the bottom brought up on the arming of the sinker is, of course, to be examined every time."

The compass and sounding machine were tried on board H. M. S. Minotaur on her recent cruise to Spain. Lord Walter Kerr (captain commanding the Minotaur) has found them to be highly successful. "Concerning the compass," he writes, "I am glad to be able to tell you that we have found it to fulfil admirably the conditions for which it was designed. The advantage of a compass like Sir William Thomson's which has no appreciable deviation on any of its points over one that has a deviation varying from a half to a quarter of a point either way in 10 out of 32 points (as is the case with the Minotaur's standard compass) is too manifest to require comment from me." Of the sounding machine he says: "The sounding machine has been most serviceable. We have been using it constantly when running up Channel. From the time of crossing the line of soundings to the time of reaching Plymouth, and though running before a gale of wind with a heavy sea, at the rate of ten knots, we were able to take soundings as easily as if the ship had been at anchor. We were able to signal to the squadron each sounding as it was obtained, thus in thick weather verifying our position by sounding without having to round the ships to. * * * I cannot speak too highly of the value of this instrument." Elsewhere he says, regarding both compass and sounding machine: "I sincerely trust that by the time I go afloat again they may be universal in the service."—*Engineering.*

THE SHIPPING OF THE WORLD.

THE New York *Journal of Commerce* gives the following table, showing the present (1877) sea-going sail and steamer tonnage of the various nations, according to the carefully-prepared statement of the *Bureau Veritas*, a world organization for the classification of vessels (gross tonnage):

	Sail		*Steamers*	
	No.	*Tonnage.*	*No.*	*Tonnage.*
British	20,625	5,807,365	3,299	3,362,992
American	7,288	2,390,521	602	769,728
Norwegian	4,749	1,410,902	122	55,874
Italian	4,601	1,292,076	114	97,585
German	3.456	875,048	226	226,888
French	3,858	725,048	314	334,834
Greek	2,121	426,905	11	5,133
Dutch	1,432	399,993	126	134,660
Swedish	2,121	399,128	219	88,670
Russian	1,785	391,625	151	105,961
Austrian	953	388,684	78	81,269
Danish	1,348	188,593	87	60,697
Portuguese	456	107,016	26	22,177
S. American	272	95,459	82	59,623
Central American	153	55,944	6	3,132
Turkish	305	48,289	30	28,264
Belgian	54	23,354	35	40,700
Asiatic	42	16,019	11	10,877
African	3	454	..	.....
Total	58,208	15,553,368	5,771	5,686,842

The report of the *Bureau Veritas* states that the losses of shipping are annually very large. Without taking any account of the coastwise craft, it may be stated that the losses of the ocean sail tonnage exceed 2,000 vessels of all flags every year. Last year they were placed at 2,300, in 1876 at 2,190, in 1874 at 2,093, in 1873 at 5,165, and in 1872, when the losses were the largest ever before known, they were 2,547 vessels; since 1868 20,000 vessels have been lost at sea. In the memorable 1872 we lost 199 sea-going vessels, and Great Britain 1,228. The losses of seagoing steamers range from 165 to 200 annually, and in 1874 the number was 244.

The capital invested in the marine of the world is almost fabulous. In 1874 it was placed at $508,327,000 in sail, and $392,016,000 in steam tonnage or a total of $900,000,000. The amount is greater to-day. The value of the steam tonnage of Great Britain is about $250,000,000, and is thus greater than that of the other nations combined. Her steam and sail tonnage combined is 9,170,357 tons, or 2,069,853 less than the combined tonnage of the other nations. It is, however, in the more effective steam tonnage that Great Britain has the advantage, because one ton of steam is equal to three or four of sailing tonnage, so far as the amount of work performed is concerned. Besides, the steam tonnage takes the cream of the travel and traffic of the ocean.

RAISING AND LOWERING WEIGHTS.

THE apparatus invented by Mr. A. Harrison, of Lincoln, Eng., consists of a frame between which are two chain or sprocket wheels, each in a piece, with worm-toothed wheels, which receive their motion from a central worm or endless screw formed upon a shaft receiving its rotation to the right or to the left by bevel gearing and hand chain wheel from outside the frame. The lift chain is a single chain, and one end, which is loose, is allowed to run freely over either of the lift chain wheels, the lift chain getting its grip for lifting purposes by the bight between the wheels by the links taking partly into each of them. The chain runs up between the two wheels, and has its load attached to a hook at its bottom end. The two chain lift wheels are of the same diameter, and their centers are truly horizontal one with the other, at equal distances from the vertical center of the worm axis or shaft, so that they travel at the same speed and lift the chain between them. The shaft of the worm is stepped at the lower part into a portion of the frame, and its upper part is within an eye or boss of the same casting, which, as part of the frame, is securely held to the other at its upper part by bolts at the socket of the suspension hook, and at the bottom by the axle bolts which carry the lift chain wheels. The hand wheel on the outside is also a sprocket wheel for an endless chain to pass over, and by which the apparatus can be worked when suspended by its hook to the projecting end of a crane, jib, or otherwise. A stoppage of the motion of the apparatus enables the load to be suspended, and a reverse motion of the hand wheel permits it to be lowered.

ROCK-DRILLING MACHINERY.

By JOHN DARLINGTON.

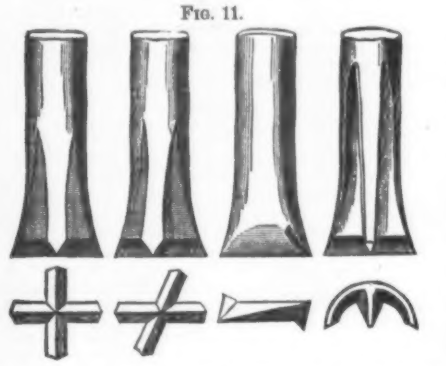
TOOLS.—The method of fixing the tool to the end of the piston-rod has received a large amount of attention from inventors. In 1866, Jordan and Darlington introduced a loop clip. Later a binding ring came into use. Improvements on these methods are in progress, the object being to retain the tool on the axial line of the piston-rod, without resorting to rings, clips, or set screws. The form of the boring bit has also undergone radical changes, in some instances rendered necessary, not for the purpose of drilling a round hole, but for neutralizing the imperfect action of the turning gear employed. The following figures, which will explain themselves, show "bits" of various forms, the use of which is advocated by inventors of various rock-drills.

Another form of tool for running down center or "rupturing" holes is shown in Fig. 12.

The bit, Z-shape, is the same size as the ordinary drills, but it has also an enlarged part, armed with a Z-shape cutting edge, 4 in. diameter. The length of the boring tools will depend upon the depth of the intended hole. At Ronchamp the longest hole was 9½ ft. At St. Gothard it is about 8 ft., while at Musconetcong Tunnel, New Jersey, the leading holes were usually 10 ft. deep, the longest 14 ft.

In ordinary mine headings, and in the employment of comparatively small boring machines, the diameter of the boring steel may vary from ⅞ in. to 1¼ in. For rupturing the rock with No. 1 dynamite, or Brain's No. 1 powder, the hole at bottom need not exceed 1 in. in diameter; but if second-class dynamite or compressed powder be employed the hole in that case should be larger. In changing a boring

FIG. 11.

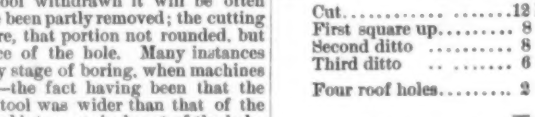


tool care must be taken that the cutting edge of the one to follow it is not wider than the intact cutting edge of the tool withdrawn. In the tool withdrawn it will be often found that the corners have been partly removed; the cutting edge of this tool is, therefore, that portion not rounded, but roughly parallel to the face of the hole. Many instances occurred in the rudimentary stage of boring, when machines were alleged to be useless—the fact having been that the cutting edge of the second tool was wider than that of the tool withdrawn, which, forced into a conical part of the hole, necessarily wedged itself fast, thereby stopping or retarding the working of the machine. As a common rule, the width of the different sets of boring tools at the points should vary from one-sixteenth to one-eighth of an inch from each other; or if the leading sets of tools are 1¼ in. wide at the point, the second or "follower" set may be 1⅛ in., and the third 1 in. wide. No rule can be strictly laid down for determining the time and power requisite to bore holes of varying diameter; but experience seems to show that if a hole 12 in. deep and 1 in. diameter takes 4 minutes, a hole 2 in. diameter and of like depth, bored with the same machine, and under the same conditions as to pressure of air and speed, will take 16 minutes. In other words, the machine and the fluid pressure being the same, the time and power to bore holes to a given depth are as the square of the diameter of the hole. It is, therefore, of considerable importance to keep the diameter of the shot-hole as small as possible, and to supplement mechanical power by employing strong rupturing explosives.

Tunnel or Mine.	Machines employed.	Machines working together.	Machines in reserve for 1 in use.	Pressure air per sq. inch.	Form of tool employed.
Mont Cenis.....	Sommellier's.......	10	7	90	Z
St. Gothard.....	Ferroux's, Dubois & François, McKean's,	6	68	90	X
Musconetcong..	Ingersoll's..........	6	....	60-70	X
Maesteg.........	Beaumont's....	2	....	50	Semicircular.
Cwmbran........	McKean's...........	2	1	70-80	Flat tool.
Port Skewet	Geach's.......... ...	2	2	60	X
Saarbruck......	Sach's	....	6	60	Flat tool.
Ronchamp......	Dubois & François..	4	1	67	X & Z.
Blanzy	Darlington...... ..	4	none	45	Flat tool.
Minera.........	Darlington..	1-2	none	50	Flat tool.
Ballacockish. ..	Darlington.....	1-2	none	45	Flat tool.

CUT AND SINK.—In tunnelling or sinking shafts by means of rock-boring machinery, it is necessary to conduct the operation in some special manner. When machines were

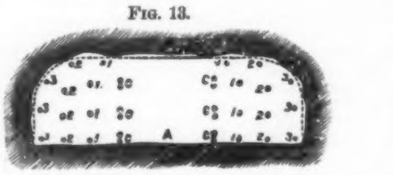
FIG. 12.



first introduced into our mines the miner insisted upon employing them as a mere substitute for the borer and the mallet, and boring the holes so as "to take advantage" of the ground. The result showed, however, that such a course was unsatisfactory. Not only was the time required to get a position for the machine, to fix, and to remove it excessive, but the work accomplished was not in proportion to its cost. The engineers of the Mont Cenis Tunnel were the first to recognize the fact that if power machines were to be successfully adopted the hand method of doing the work must be discarded and new conditions established. A given number, ten machines, were accordingly grouped together on a carriage, the natural rupturing lines of the rock disregarded, the holes drilled more or less with the axial line of the heading, the machines and carriage withdrawn, the holes charged, the explosive fired, and the stuff removed.

These series of operations constituted an "advance," while in America, and in one or two English mines, it is known as a "cut," and in shafts as a "sink." At the time when the Mont Cenis Tunnel was driven, nitroglycerin and dynamite had not been largely adopted for blasting purposes. Powder was the explosive used in the execution of that work; this, together with the great length of the machines and comparatively narrow width of the heading—9 ft. 10 in.—thereby limiting the angling range of the machines, rendered a considerable number of holes necessary for effecting the removal of the rock. A face of 83¼ square ft. was perforated with from 60 to 70 holes, 2½ ft. to 4 ft. deep. The Musconetcong Tunnel, New Jersey, was driven with the aid of dynamite. The advance heading, 8 ft. high, was carried the entire width of the tunnel—26 ft. With two boring carriages, and strongly angling the machines on a

FIG. 13.



line from the top to the bottom of the tunnel towards its axial line, holes 10 ft. deep were made for bringing out the center "cut." The methods of arranging the holes for blasting may be distinguished as—

(a).—Mont Cenis and St. Gothard.
(b).—Musconetcong and Minera.
(c).—Brain's radial system.

(a).—The face of the Mont Cenis heading, allowing for contraction towards the top and rounding corners, represented an area of about 80 square ft. This "face" was subjected to the attack of 10 machines, giving 8 square ft. of surface per machine, or nearly one hole for each square foot of surface.

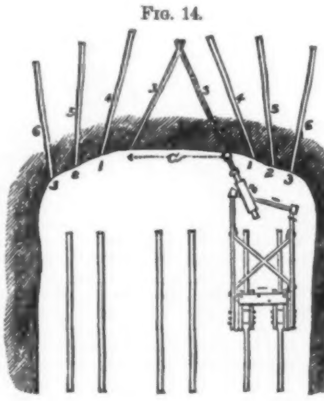
The center of the face was perforated with a large hole, and immediately outside of this center 8 other holes were bored, constituting the "center or rupturing holes." Around this set of center holes a series of 3 sets of concentric and 2 sets of semi-concentric holes were drilled. The holes were subsequently fired in volleys and removed the rock—(1) the center, and (2) the portion concentric to the center. See Fig. 16.

(b).—At Musconetcong the tunnel heading, 26 ft. wide by 8 ft. high, gave a net area of about 175 square ft. This face was perforated with 36 holes by means of 6 powerful boring machines, each cylinder 5 in. diameter. The area of the face apportioned to each machine was 29 square ft. The number and depth of the holes to obtain a cut of 10 ft., or an actual lineal advance of 9 ft., were:

Cut..............	12 holes, each		10½ ft. deep.	
First square up.........	8	"	12	"
Second ditto	8	"	12	"
Third ditto	6	"	12	"
Four roof holes.........	2	"	10 / 8	"
Total......... ..	36			

The aggregate depth of the 36 holes was 408 lineal feet; number of square feet of heading to one hole about 4·8. The following is Mr. Drinker's description of driving by the

FIG. 14.



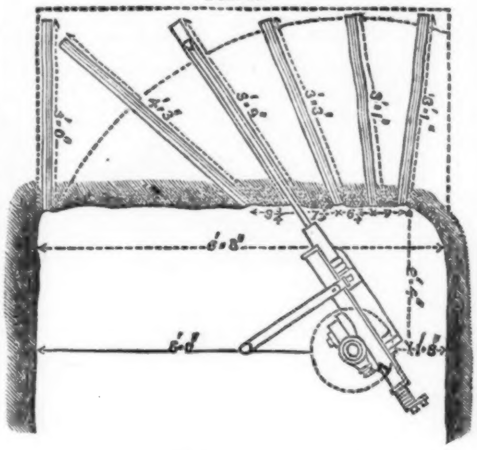
cut system: "The method of blasting by cuts is based on the extraordinary force developed by a comparatively small bulk of explosive matter. It consists in first blasting out an entering wedge or core, about 10 ft. deep at the center, and subsequently squaring up the sides by several rounds. To do this 12 holes are first drilled by 6 machines, 3 on a side, the holes placed as shown in Fig. 13, and marked C; A being the floor of the heading. Then 12 holes are drilled, 2 and 2, 6 on a side, with from 1½ to 2¾ in. "bits," the two sets being started about 9 ft. apart, and at such an angle (see Fig. 17) as to meet or cross at the bottom, the largest bit being put in first. The holes are then charged with about 25 lbs. No. 1 and 50 lbs. No. 2 dynamite, and fired simultaneously by electricity. No. 1 is only used for cuts, inasmuch as in them a quick, strong powder compressed in a small bulk at the bottom of the holes is required where the greater resistance will be found, while the No. 2 added serves in filling up the holes, so starting the sides of the cut as the apex moves—the cut, a, being out, a second round of holes is started for the first squaring up, as shown by the numbers 1, 1, 1, 1, Figs. 13 and 14.

In these and subsequent rounds, 2, 2, 2, 2 and 3, 3, 3, the resistance is pretty equally distributed along the whole length of the holes, and as it is not so great as in the cut, No. 2 is used, as in it, the nitroglycerin being mixed with a larger proportion of absorbent matter, the force is thereby distributed over a greater space. In the first and second squaring up, rounds from 50 to 60 lbs. of No. 2 are charged, and in the third, from 80 to 90 lbs., the holes getting stronger as the arch falls at the side. There are generally, also, one or two additional roof-holes in the third round that are not shown in the figure, their position being variable, according to the lay of the rock. The top holes in the first round are also designed to bring down the roof not shaken by the cut, and are, therefore, given a strong angle towards the center, and always drilled from 12 to 14 ft. deep. The plan, Fig. 14, shows the cut holes, 4, 5, and 6 the squaring up rounds.

"As to the relative depth the holes of the first squaring up round are always drilled a foot or more deeper than the cut-holes, and when blasted they generally bring out a foot additional of shaken rock at the apex of the cut."

(c).—BRAIN'S RADIAL SYSTEM.—This system, devised by Mr. W. Blanch Brain, of St. Annal's, Cinderford, was introduced about three years ago at the Drybrook Iron Mines, in the Forest of Dean. The main object of the inventor was to perforate the face of a level without once shifting the stretcher-bar when placed at its proper height. M. André, in his work on Coal Mining, thus notices the radial system: "The fundamental principle which constitutes its distinctive character is to make the holes of a series to radiate from a fixed point. The object of this radiation is twofold—to utilize the face of the heading as an unsupported side, and to reduce to a minimum the time consumed in changing the position of the stretcher-bar. It will be obvious on reflection that if these ends are attained

FIG. 15.



without incurring a compensating loss the merits of the system are beyond question, since their attainment leads to rapidity of progress, which is the main purpose of machine labor. It is evident that if the holes are made to radiate from a fixed point, and the horizontal position be avoided, none of them can be perpendicular to the face of the heading, and, consequently, the lines of fracture from each charge tend to reach this face. A consequence of this fact is that no unkeying of the face is necessary, since each shot tends to blow outwards. Let it be assumed that the drift to be driven is 6 ft. 8 in. in height. The width in this case is immaterial to the operation of the system. The stretcher-bar, which is to serve as a support to the machine, is fixed at a certain height from the floor, and at a certain distance from the face, as shown in Fig. 15. The height of the bar above the floor, with slight modifications to suit existing conditions, will be the same in all cases; but the distance of the bar from the face will be determined by the length of the machine, or at least by the distance from the centre of the clamp to the end of the piston-rod, into which the bit is fixed. It is obviously desirable to reduce the distance between the face of the heading and the stretcher-bar to the least possible, since the angle of the holes will rapidly increase as the distance is diminished. From the figure it will be observed that the stretcher-bar is fixed 1 ft. 8 in. from the top, 5 ft. from bottom, and 2 ft. 4 in. from the face. The first and second series of holes are 3 ft. 1 in. deep; the third, 3¼ ft. deep; the fourth, 3¾ ft.; and the fifth, 4½ ft. deep. The bottom or lifting holes are 3 ft. long.

In a heading 6 ft. 8 in. by 6 ft. 8 in., giving an area of 44 square feet, 29 holes were bored, representing a total lineal length of 69 ft. 8 in. As the cut or advance was about 3 ft., it follows that each hole removed nearly 7 cubic feet of rock.—*Mining Journal.*

THE INSTITUTION OF CIVIL ENGINEERS.

SUBJECT FOR PAPERS.—SESSION 1877-78.

THE Council of the Institution of Civil Engineers invite communications of a complete and comprehensive character, on any of the subjects included in the following list, as well as on other analogous questions. For approved original communications, the Council will be prepared to award premiums, arising out of special funds bequeathed for the purpose, the particulars of which are as under:

1. The Telford Fund, left "in trust, the interest to be expended in annual premiums, under the directions of the Council." This bequest (with accumulations of dividends) now produces about £260 annually.

2. The Manby Donation, given "to form a fund for an annual premium or premiums for papers read at the meetings," of the annual value of £10 a year.

3. The Miller Fund, bequeathed by the testator "for the purpose of forming a fund for providing premiums or prizes for the students of the said Institution, upon the principle of the 'Telford Fund.'" This fund (with accumulations of dividends) now realises nearly £180 per annum. Out of this fund the Council have established a scholarship—called 'The Miller Scholarship of the Institution of Civil Engineers'—and are prepared to award one such scholarship, not exceeding £10 in value each year, and tenable for three years.

4. The Howard Bequest, directed by the testator to be applied "for the purpose of presenting periodically a prize or medal to the author of a treatise on any of the uses or properties of iron or to the inventor of some new and valu-

able process relating thereto, such author or inventor being a member, graduate, or associate of the said Institution." The annual income amounts to rather more than £16. It is proposed to award this prize every five years, commencing in 1877.

The Council will not, in any case, make an award unless a communication of adequate merit is received; but, on the other hand, more than one premium will be given, if there are several deserving memoirs on the same subject. In the adjudication of the premiums no distinction will be made between essays received from a member, an associate, or a student of the Institution (except in the cases of the Miller and the Howard bequests, which are limited by the donors), or from any other person, whether a native or a foreigner.

List.

1. The Triangulation Survey, and Mapping of Countries and Districts, including the Astronomical Observations required for latitude and longitude, and measurement of bases; with a description of the instruments employed, the reduction of the observations, and the degree of accuracy of the results.

2. The Levelling of Countries, either by Spirit-levelling, vertical angles, barometers, or the boiling-point of water; with a description of the instruments employed, the reduction of the observations, and degree of accuracy of the results.

3. The Manufacture of Cements, comparing the processes followed in different countries.

4. The Manufacture of Bricks by Machinery, including descriptions of special kilns, &c.

5. The Effect of the Lapse of Time on the Strength of Materials strained beyond the supposed limit of elasticity, but within the ultimate strength.

6. The Causes of Slips in Rocks and Earths of different kinds, and the Conditions that induce treacherous ground in railway cuttings, tunnels, and the sides of valleys near reservoir banks.

7. The Application of Steam Machinery for Excavating, and the Cost as compared with Hand Labor.

8. The Results of the Use of Steel in Mechanism and in works of Construction.

9. The Construction of Warehouses and of other Buildings to resist Fire, and the relative merits of stone, brick, iron, and timber for that object.

10. The Warming and Ventilation of large Buildings.

11. The different Systems of Road-making best adapted for large towns, or where the traffic is heavy, including a Comparison of First Cost, Maintenance, and Durability.

12. The Design and Construction of Masonry Dams of great height for retaining water in reservoirs.

13. The Storage and Filtration of Water, both natural and artificial.

14. The Benefits and Expedients of Irrigation in India and in other warm climates, and the proper construction of irrigating Canals, so as to avoid erosion or silting, and to prevent the growth of weeds.

15. The constant service of Water Supply, with special reference to its introduction into the Metropolis, in substitution for the Intermittent System.

16. The systems of Domestic Water Supply suitable for rainless districts.

17. The different systems of Opening Bridges, with details of the modes of working them.

18. The Design, generally, of Iron Bridges of very large span, for Railway traffic.

19. The Design and Construction of Dock Gates and Caissons, including the requisite external and internal arrangements, illustrated by recent practical examples.

20. The Design and Construction of Building Slips for large Vessels.

21. The Appliances and Methods used in different countries for Tunnel driving, Rock-boring, and Blasting, with details of the cost and of the results attained.

22. The Works carried out for the Improvement of the Seine and other French rivers, and of Inland Navigation generally.

The relative Value of Upland and of Tidal Waters in maintaining rivers, estuaries, and harbours.

24. The Construction of Tide Gauges, and the usual method of carrying out a systematic series of Tidal Observations.

25. The differences in Design of British and Foreign Locomotive Engines; showing the benefits derived from increase in weight, and the relation that ought to exist between the diameter of the wheel and the load it has to carry.

26. The Lighting of Railway Carriages.

27. The construction of Steam Boilers adapted for very High Pressures.

28. The best practical Use of Steam in Steam Engines, and the effects of the various modes of producing Condensation, and of various grades of expansion.

29. The Modern Construction of Marine Engines, having reference to economy, by Superheating, Surface Condensation; High Pressure, great Expansion, &c.

30. Modern Experience in Screw Propulsion, comprising the comparative efficiency of propellers of large diameter, and of smaller ones deeply immersed, and the influence of form.

31. The best Shapes for Yachts and for Ships for commercial purposes.

32. The relative Efficiency of the Screw Propeller and Paddle Wheels for towing purposes.

33. A Comparison of the different Modes of transmitting Power for auxiliary purposes on board Ships, and in Shipyards, and Engine Factories.

34. The various descriptions of Pumps employed for Raising Water or Sewage, and their relative efficiency.

35. The relative advantages of Wind and Water as Motive Powers, compared with Steam Power, and the Motors most suitable for utilizing them.

36. Compressed Air as a Motive Power, particularly as applied to Machinery in Mines and to Locomotives in Tunnels, with some account of its application on the Continent.

37. The Manufacture of Mineral Oils, and the Lamps best adapted for their consumption in dwellings and lighthouses.

38. The "Output" of Coal in the United Kingdom, as compared with that of other countries, illustrated by statistics, showing where Coal is produced, where and how it is consumed, and the relative quantities exported.

39. The Methods and Machinery employed in sinking and in working deep Coal Mines.

40. Coal Depots for Ocean Steamers, the various points involved in their management, and the methods of preserving large quantities of coal from deterioration.

41. The Metalliferous or other Mining Districts in different countries, and the mode adopted in working them.

42. The Methods employed in securing the Excavations in mining large and irregular-shaped mineral deposits, for example, the Almaden Mines, the Great Comstock Lode, etc.

43. The appliances used in different countries for Dressing the Ores of Lead, Copper, Zinc, and Tin, and the Smelting of such Ores, with details of the results and cost by various methods.

44. The Losses in the Reduction of Metallic Ores by different methods, distinguishing losses in dressing from those in smelting.

45. The Disposal and Utilization of Slags from various smelting processes.

46. The Management of Underground Waters in mining districts, and the relative economy of distributed or trunk pumping engines, adits, etc., in particular cases.

47. The Appliances and Processes for the manufacture of Artificial Fuel in different countries.

48. On recent Progress in Telegraphy, with a notice of the theoretical and practical data on which that progress has been based.

49. Electricity as applied to Lightning Purposes.

50. On Torpedoes, and their influence on Naval Construction.

Instructions for Preparing Communications:

The communications should be written in the impersonal pronoun, and be legibly transcribed on foolscap paper, on the one side only, leaving a sufficient margin on the left side, in order that the sheets may be bound. Every paper must be prefaced by a concise abstract.

All communications should be accompanied with a set of drawings on tracing paper, to as small a scale as is consistent with distinctness, and ready to be engraved. If accepted for reading then there will be required a series of diagrams (which will be returned) sufficiently large and boldly colored, so as to be clearly visible when suspended in the theatre of the Institution.

Papers which have been read at the meetings of other societies, or have been published in any form, cannot be read at a meeting of the Institution, nor be admitted to competition for the premiums.

The communications must be forwarded to the house of the Institution, where any further information may be obtained.

Charles Manby, Honorary Secretary.
James Forrest, Secretary.
25 Great George-street, Westminster, London, S. W.
October, 1877.

PHYSICAL SOCIETY, LONDON.

November, 1877.

Prof. McLoud described some experiments he has recently made to determine the exact number of vibrations of tuning-forks by means of the apparatus he exhibited to the Society on the 28th of April last, which was designed for determining slight variations in the speed of machinery or other analogous purposes. He has studied two sets of forks belonging to the Physical Laboratory at South Kensington, and a new set just received from Kœnig, and his results exhibit a remarkable concordance, the extreme results in the worst set of observations on a fork of 256 complete vibrations only differing by 0·005 per cent.; and in a good set they agreed within 0.0078 per cent. Examining the new series, from 256 to 212, he found them in all cases to give from 0·3 to 0·5 of a vibration more than was anticipated, but as this variation may be due to a difference between the temperature and that at which they were adjusted, he is waiting to ascertain what this was. In reply to an inquiry of Dr. Guthrie, he stated his belief that a change in all probability does take place in the molecular condition of a fork with age. He considers also that the manner in which the fork is held has an effect upon its vibrations, and he hopes to be able to get some information as to the effect of temperature on elasticity.

Dr. Huggins exhibited some artificial gems recently prepared by M. Feil, the well-known glass manufacturer of Paris. He has succeeded in crystallizing stones of the corundum class; and rubies, as well as a topaz and emerald, were exhibited. Dr. Huggins believes that the color is imparted by small quantities of metallic oxides, and that the mass is mixed with boracic acid and maintained in a fumed condition for a considerable period. M. Feil hopes to obtain larger stones by maintaining the heat constant for several weeks consecutively.

Dr. Lodge then read a communication from Profs. Ayrton and Perry, of the Imperial College, Japan, in continuation of one read to the Society on the 26th of May last, on "*Ice as an Electrotype*," and since published in the *Philosophical Magazine*. The experiments therein described led them to expect a very sudden rise in the specific inductive capacity as the temperature of the ice increased through zero, and it became water. Recent results have shown that, though rapid, this increase is not as great as they anticipated, and, whereas at $-12°$ C. the capacity is 0·002 microfarad, at $+5$ C. it is 0·1185 microfarad, and after this temperature the increase was so rapid as to render exact readings difficult Referring to Prof. Clerk Maxwell's theory, comparing electro-magnetic disturbances with light vibrations, they point out that he exclusively regards a conducting medium. But they showed in a former paper that no dielectric can be considered non-conducting, hence they conclude that the measured specific inductive capacity can never be even approximately equal to the square of the index of refraction.

Prof. Foster mentioned that he recently had occasion to collect as many results as possible on specific inductive capacity and refractive index, and he found that where these figures were low the agreement with the law was fairly close, but with greater values the inductive capacity and the square of the refractive index separate very rapidly.

Prof. Guthrie described a simple means for showing the interference between plane waves by means of two long cords vibrating side by side. If a vibration of considerable aptitude be imparted to them, and the plane in which they travel be carefully examined, two faint black lines will be seen, which cross and re-cross each other more rapidly as the cords are less and less in union, and with perfect unison remain stationary.

Manganese Bronze.—According to Gintl, a tough, malleable bronze, of nearly the color of brass, contained 76·710 parts copper; 16·147 manganese; 5·490 zinc; .320 iron; ·762 tin and silicon. This represents an alloy of 15 parts copper, 4 parts manganese, and 1 part zinc.—*Techn. Blatter.*

PROFESSOR RANKINE.

Prof. W. S. Macquorn Rankine was born in Edinburgh, July 4, 1820, and on Christmas Eve, in 1872, he died, before he had completed his fifty-third year; but in that comparatively short life he had won higher distinction and done more good work than it falls to the lot of most men to compass.

He pursued his ordinary school studies in the Burgh Academy of the town of Ayr, the high school of Glasgow. When

W. J. MACQUORN RANKINE.

very young he entered the University of Edinburgh, where he devoted himself to natural philosophy and natural history, including zoölogy, geology, mineralogy and botany. He was a born mathematician, and received little aid from professional instruction in the branch of science in which he subsequently displayed such great genius. Throughout his educational course he received valuable aid from his father, who was a retired lieutenant of the British Army.

His powers were developed at an early age. Before he was twenty he had written two essays on subjects in pure physics. At eighteen he adopted the profession of civil engineering, and was the pupil of Sir John Macneil for three or four years, a great part of which was spent on engineering works in Ireland. Subsequently, he was employed for several years on railways and similar works in Scotland; and in 1850, forming a partnership with Mr. John Thomson, C.E., he settled in Glasgow.

Meanwhile he had been busy in purely scientific pursuits not connected with his calling, and the value of his work was generally recognized. He was elected to various learned societies, and in 1853 was made a Fellow of the Royal Society of London. The same year he became a member of the British Association, in which he subsequently held several important positions. During the Dublin meeting of the Association in 1857, the honorary degree of LL.D. was conferred upon him by the university of that city as a mark of the eminence he had gained as a physical investigator. He was then but thirty-seven years old.

In 1856 he was made Regius Professor of Civil Engineering and Mechanics in the University of Glasgow, a position which he held with distinction for seventeen years. He was an able instructor, his aim being to develop the understanding of the student by the cultivation of natural knowledge, and to beget those habits of close observation and persistent and exact verification which are so essential to the scientific worker in any field.

Prof. Rankine was the first President of the Institution of Engineers of Scotland, and in 1861 was made President of the Philosophical Society of Glasgow, contributing many papers to the Proceedings of that Society, and on a wide range of topics. The honors he won in his profession, and in thermo-dynamics, were rivaled by his achievements in naval architecture, to which his attention was for some time given.

His writings were exceedingly voluminous. His published treatises and manuals included, among others, "Manual of Applied Mechanics," "Manual of the Steam-Engine and Other Prime Movers," "Civil Engineering," "Useful Rules and Tables," "Cyclopædia of Machine and Hand Tools," "Manual of Machinery and Mill Work," besides a very long catalogue of papers on physics, especially thermo-dynamics, applied mechanics, etc. His style was a model of scientific writing—elegant, exact, lucid in explanation, and apt in illustration. In short, his was a mind of the first order, his original investigations were of the highest value, and his excellent influence as an instructor in moulding the minds of his students will be far-reaching.

His early death was the penalty of overwork and was preceded by an impairment of vision and a derangement of the heart's action that were very distressing. He yielded to the demand for bodily rest when it became imperative; but it was too late. His is another name added to the long list of those who, understanding perfectly the limits of human endurance, seem to think that their case is exceptional, that their organisms can be continuously overworked with impunity, and so go on, heedless of the dumb protests of the abused body, until the ruin is utter and irrevocable.—*Popular Science Monthly.*

Domestic Use of Aluminum.—Recent experiments show that pure aluminum could be employed much more extensively than has generally been supposed, provided a cheap method was devised for procuring it. Spoons made from aluminum, from German silver, and from silver, were subjected for a year to constant use, under similar conditions. The resulting wear was 0·630 per cent. for aluminum; 1·006 per cent. for German silver; 0·403 per cent. for silver.—*Berg u. Huetten Zeit.*

Sketching-Paper.—MM. Carl Schleicher and Schull, of Duren, Germany, prepare rolls of sketching-paper of excellent quality, and uniformly ruled in squares of ½ centimetre, ¼ centimetre, and 1 millimetre on the side. The difference in the breadth of the rulings is so plainly marked that any projections can be readily made, without instrumental measurements.—*Pap.-Zeitung.*

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MacCord.

Second Series.—No. XVI.

On the Screw Propeller.—Continued.

The acting surfaces of the propeller blades described in the preceding lessons have this feature in common, that they have rectilinear generatrices, of which each point describes a helix of the same uniform pitch. The generatrix might be perpendicular to the axis, or it might not; but in either case the propeller would be properly called a "true screw," being a square or a V-threaded one according to the inclination of the elements to the axis. The expression "true screw," then, clearly indicates a distinction from other surfaces partaking of the helicoidal nature, but not possessing the regularity due to constancy and equality of the pitches of the helices of which they are composed.

Among these surfaces, employed as the acting faces of propeller blades, are those indicated "screws of expanding pitch." And further, we meet with the terms "radially expanding" and "axially expanding" pitch, in regard to which it is necessary first of all to have definite ideas and a clear understanding.

Now, supposing a cylinder to be put in the lathe and caused to rotate with uniform velocity, a tool, set so as just to scribe a line upon it, may be moved along in a direction parallel to its axis. If the end-long motion of the tool be uniform, the line traced upon the cylinder will be the common "true helix," with which we are familiar, and its development will be a right line. (See Figs. 216 and 217, Lesson 24, 1st series.) But the rate at which the tool moves is entirely arbitrary and independent of the rate of rotation, and we may therefore move it with an accelerated velocity, if we choose, or a retarded velocity. In either case, the rotation being uniform, the line traced will not be a "true" helix, but a helix of increasing or decreasing pitch, as the case may be: the distinction, obviously, having reference only to the direction of the end-long motion, since, if increasing in one direction, the pitch must be decreasing in the other. A practical instance will readily occur to the reader in the case of a rifle grooved with a "gain twist."

Now let the tool be fed in toward the axis, but moved end-long precisely as before; a second increasing pitch helix would be traced on the surface of a smaller cylinder, the tool being supposed to cut a groove in the original one. By repeating the process this groove may be cut as deep as we please, and it will be bounded evidently by a surface all of whose helical lines will have the same varying pitch. The surface will also have rectilinear elements, since the tool was fed in a right line toward the axis. That is to say, the surface may be generated by a right line, rotating at a uniform rate about an axis, which it intersects at a constant angle, and at the same time advancing along the axis with a varying velocity. Such a surface may properly be called a helicoid of *axially* expanding pitch: if the generatrix be perpendicular to the axis, it will bear a close resemblance to the true right helicoid; if not, it will be more closely allied to the oblique helicoid discussed in the last lesson.

If we develope the surface of the cylinder on which the helix of increasing pitch is traced, that line itself will not be straight, but curved, which is as much as to say that if any curve be drawn on a plane, and that plane then wrapped up into a cylinder, the curve will then become a helix of varying pitch, an instance of which was given in the first series (Lesson XXIX., Figs. 251 and 252).

Next, what is meant by a screw with radially expanding pitch? This may be best answered with the aid of a diagram, Fig. 107. We have here a horizontal line $a\,c$, intersecting the vertical axis at c; were this line to rise to the position $v\,k$, rotating and advancing uniformly, it would generate a right helicoid, the point a describing the true helix $a\,m\,v$. But now let us suppose that while the line rotates uniformly, in contact with this helix, the point c advances uniformly, but at a slower rate than before, so as in the half revolution to reach the position z instead of k. By this motion the right line will generate a different surface, which is the screw with radially expanding pitch. In regard to this, it must be noted that since $z\,v$ is longer than $c\,a$, the point a of the generatrix does not describe the helix $a\,m\,v$, but, the point c always touching the axis, there is a sliding of the generatrix upon the helix during the motion. Now in the half plan below, let the smaller circle be the base of a cylinder concentric with the larger one: then $a\,c$ pierces this cylinder at b, and $z\,v$ pierces it at x. If we set off $a'\,m'$, one-third of the semi-circumference $a'\,v'$, and draw the radius $m'\,c'$, the latter will represent the generatrix in that view: in the side view m' will be seen at m on the helix $a\,m\,v$, $m\,l$ being, of course, one-third of $v\,w$: set off $c\,o$, one-third of $c\,z$, and $m\,o$ will be the side view of the generatrix in its new position. It now pierces the smaller cylinder in a point seen in the plan view as n', which, being projected to $m\,o$, fixes n, the corresponding position of that point in the side view, of which the altitude $n\,p$ will obviously be one-third of $x\,r$. So, also, if $a'\,d'$ be one-sixth of the semi-circumference, the generatrix will pierce the smaller cylinder in a point seen as e', e, and the altitudes of d and i being one-sixth of $v\,w$ and $c\,z$ respectively, that of e will be one-sixth of $x\,r$. Consequently the line joining these points of penetration, that is to say, the intersection $b\,e\,n\,x$ of the surface under consideration, by the smaller cylinder, will be a true helix. Our screw with the radially expanding pitch, then, is composed, like the right and oblique helicoids, of helical elements lying on concentric cylinders, but the helices have different pitches: this striking characteristic must not be lost sight of, that although it is generated by the motion of a right line, no point of this line describes the helix.

It is clear, too, that the two helices and the axis fully control the motion of the generatrix; for, if we imagine $a\,m\,v$ and $b\,n\,x$ to be two wires, bent into the helical form and fixed in the positions shown, $c\,k$ being a straight wire, it is easy to see that another straight wire $z\,v$, in order to slide down into the position $c\,a$, in contact with all the other three, must always remain in a radial plane of the cylinders; if we restrain the motion of the outer end, causing it to descend the outer helix at any given rate, it will slide down the inner one by the force of gravity, the speed of its motion being controlled by its contact with the vertical wire. In the first instance, we supposed the outer helix, and the advance along the axis, to be given, which determined the pitch of the helix on the smaller cylinder; but from the above illustration it will be apparent that, if we fix the pitches of both helices, the linear advance along the axis will be thereby determined.

And in the practical adaptation of this surface to the formation of the propeller blade, the data are usually given in the latter form; for instance, the diameters of the screw and the hub being stated, the pitches of the helices at the rim and hub respectively, are stipulated, which of course determines the surface. Thus in the figure, let $a\,w$ be the diameter of the propeller, $b\,r$ that of the hub, $w\,v$ the half pitch at the rim, $r\,x$ the half pitch at the distance $c\,r$ from the axis. Prolong $v\,x$ to cut the axis in z, and draw $x\,s$ and $z\,g$ perpendicular to the axis, the latter cutting $r\,x$ in h. Then $v\,s = w\,v - x\,r$; and forming similar triangles,

$$xs : zg :: vs : vg,$$

whence $$vg = vs \times \frac{zg}{xs}$$

And then, $$cz = wv - vg.$$

Of course, the terms may be doubled without affecting the result; that is to say, we may use at once the diameters and the entire pitches, as they are given, instead of the radii and the half pitches, which we have here done for the purpose of avoiding confusion in the diagram.

The pitch at any other distance from the axis, as $c\,y$, may be found as follows: draw $y\,u$ parallel, and $u\,f$ perpendicular, to the axis; then

$$zg : zq :: vg : uq$$

$$\therefore \quad uq = vg \times \frac{zq}{zg};$$

and $$uy = uq + cz.$$

Otherwise thus:

$$xs : uf :: vs : vf,$$

$$\therefore \quad vf = vs \times \frac{uf}{xs},$$

and $$uy = wv - vf.$$

Now, when the pitches and diameters are thus given, it is commonly supposed that we ought to be able to make the propeller, if furnished in addition with the limits of the size of the blade, as for instance, if the space within which it is to turn be defined, as in the preceding examples. This is, however, a mistake, as will be seen from Fig. 108.

This represents a portion of the surface generated by a right line $o\,o$ of definite length, the pitch at the axis being $o\,b$, $b\,d$, while that on the cylinder $x\,z$, whose radius is $o\,o$, is $o\,f$, $f\,x$.

Thus the line $o\,o$, which is perpendicular to the axis, assumes in successive half-revolutions the positions aa, bb, cc, etc., as it travels to the right, and the positions 1-1, 2-2, 3-3, etc., as it travels toward the left; the outer extremity o of the generatrix describing the *quasi*-helical curve $2\,1\,o\,a\,b$, etc., which lies on a surface of revolution whose axis is $C\,C$, and meridian outline $m\,2\,o\,b\,n$. In order more clearly to exhibit the peculiarities of the surface thus generated, we have introduced a concentric cylindrical core $g\,h$, whose intersection with the surface is, as shown, a true helix.

Clearly, the surface may be extended indefinitely in either direction, the angle between the generatrix and the axis becoming more and more acute as we recede from $o\,o$, the two ultimately coinciding, so that the outline $o\,b\,n$, $o\,2\,m$, if produced, will be tangent to $C\,C$ at an indefinite distance, that is to say, the axis is an asymptote to the curve.

Thus the surface, extending to infinity on either hand, is divided by the central transverse plane $L\,M$ into two very dissimilar parts: in the immediate neighborhood of $L\,M$ there is a bit of nearly neutral territory, in which the surface is similar to the right helicoid; on the left, it will be seen by comparison with Fig. 106 that it resembles the upper side of the oblique helicoid, or surface of the *V*-threaded screw, while on the right it is like the lower side of the same screw-thread. Now, in Fig. 108, $x\,z$ may be the diameter of a propeller, $g\,h$ that of the hub; if the pitches of the helices on these two cylinders be given, the surface is determined, it is true; but a mere statement in addition, of the magnitude of the part of the surface to be used, evidently does not fix its location, and from those data alone any number of propellers may be made, so different from each other that the identity of their surface would never be suspected by one not in the secret, from which it is scarcely reasonable to suppose that similar results would be obtained.

It is, then, necessary to stipulate the precise location of the part of this surface to be used; which may be done by fixing the inclina ion of some one element of the proposed blade; if for example it be stated that the element at the middle of the length of the hub shall be perpendicular to the axis, it is then clear that we are confined to the neutral ground near $L\,M$; if it inclines aft, we must use a part of the surface farther to the left, and if it lean forward, we must go farther to the right.

Now, in Fig. 109, we give, not a drawing of an actual propeller, but a rather exaggerated case, as an exercise in the application of this surface, and in the operations involved in drawing it. We have here a cylindrical hub, and the blade is limited by two planes perpendicular to the axis. The central element $o\,c$ is also perpendicular to the axis, corresponding to $o\,o$ of Fig. 108: it therefore lies in a plane which divides the blade into two equal and symmetrical parts, so that the explanations relating to the drawing of one edge apply also to the other. The diameter of the propeller is 6 feet, that of the hub 12 inches; the pitch at the rim 12 feet, that on the hub 6 feet, and the length of the hub 15 inches.

Through o is drawn a helical arc, cut at a and b by the limiting planes; b in its revolution will rise to x, and $o\,x$ being a known fraction of the pitch, we set off $o\,b$, the same fraction of the circumference; $C\,b$ in the end view is then the true position of the element whose highest revolved position in the side view is $x\,u$, $c\,u$ being one-half of $c\,v$ or $o\,x$, because the inner pitch is half the outer. If, then, we lay off $x\,z = o\,x$, $z\,v$ will be the highest revolved position of the element, whose true position may be found by dropping the perpendicular $z\,p$ to cut the helix through o in f, and drawing $f\,g$, g being the point in which $z\,v$ produced meets the axis. Or, better, in the end view set off $b\,f = o\,b$, and draw $C\,f$, cutting the circle of the hub in e; $f\,g$ in the side view is also cut in e by the forward limiting plane, and the determinations of this point by the two methods ought to tally with each other. We have now the two points b and e, which in the end view will be joined by the curve of intersection between the screw surface and the transverse plane by which the blade is limited. We might find points in this curve on general principles, thus: Any horizontal line as $p\,p$ may in the side view represent an element of a cylinder, on which we know that there will be a true helix, whose pitch we can ascertain, as before explained, and this will be cut by the limiting plane at a point of the required curve. Thus in the figure, p is midway between o and c; the pitch of the helical arc $p\,r$ is therefore 9 feet, and its intersection r with $a\,d$ in the side view to be projected to r on the corresponding circle in the end view. But this mode of operation is open to two objections; it is too laborious to construct the helices, if we can do as well without it, and when we have done so, the intersections in the end view, of the projecting lines like $r\,r$ with the circles, are likely to be more acute than is desirable. We therefore give in Fig. 110 a diagram illustrating a mode of determining these points with greater precision. The proportions are quite different from those in Fig. 109; but the corresponding letters will enable the reader to perceive the substantial identity of the two cases. $C\,C$ being the axis, $h\,x$ and $g\,z$ represent the two positions of an element of the surface, revolved into the plane of the paper, $u\,v$ being the linear advance on the inner, $x\,z$ that on the outer cylinder, and it is required to find the intersection of the surface with the plane $v\,x$. Divide $u\,v$ and $x\,z$ into the same number of equal parts, at the points 1, 2, 3, 1′ 2′ 3′; then the lines 1-1, 2-2, 3-3, represent intermediate positions of the element, revolved into the same plane, which in the end view will appear in their true positions as equidistant radii, whose lengths measured from the inner cylinder outward will be $v\,d$, $v\,e$, $v\,f$, or, in Fig. 109, $v\,1$, $v\,2$, $v\,3$, $v\,4$; but as in this case the intersections also may be too acute, the lengths of these radii may be calculated, thus:

Drawing the parallels $c\,3'$, $b\,2'$, $a\,1'$ we observe that the tri-

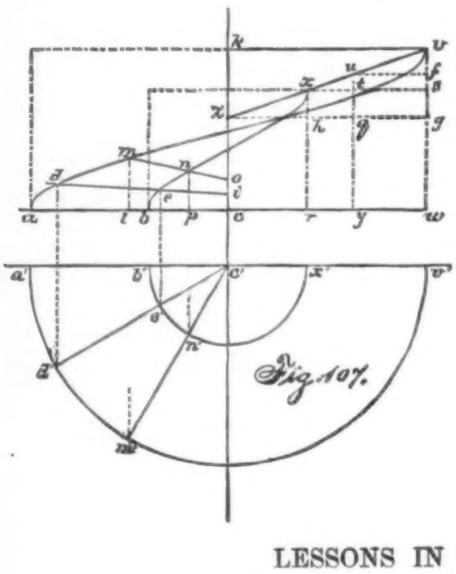


Fig. 107.

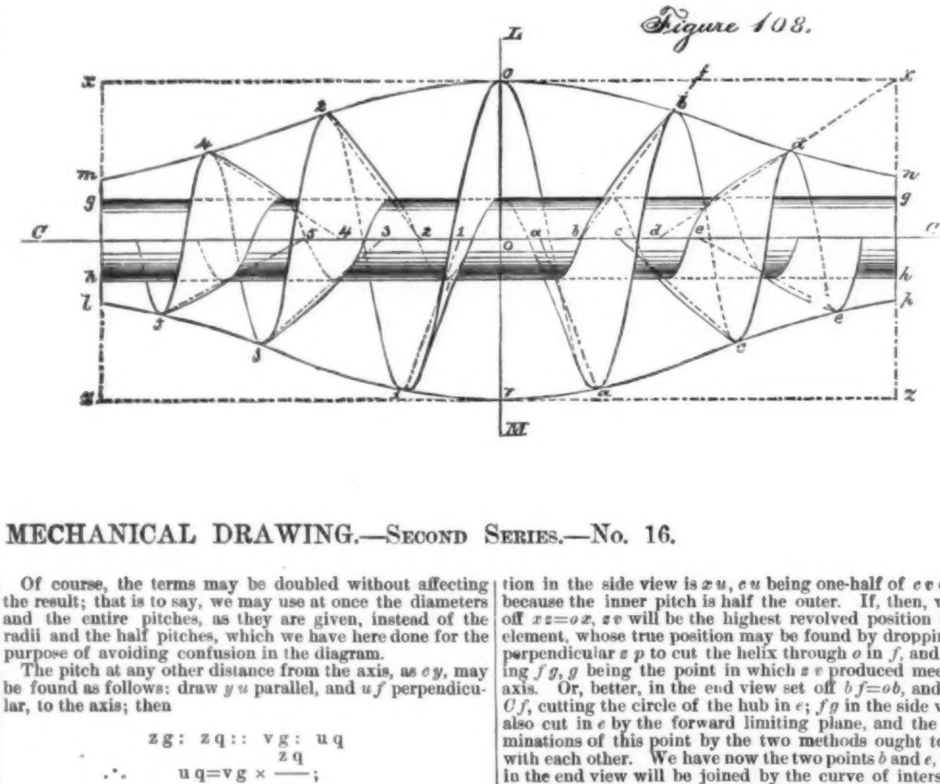


Figure 108.

LESSONS IN MECHANICAL DRAWING.—Second Series.—No. 16.

angles c 3–3', v d 3' are similar; as also are b 2–2' and v e 2. and a 1–1' is similar to v f 1; whence

$$\frac{v\,d}{v\,x}=\frac{v\,3}{c\,3},\quad \frac{v\,e}{v\,x}=\frac{v\,2}{b\,2},\quad \frac{v\,f}{v\,x}=\frac{v\,1}{a\,1}$$

For greater facility, it will be convenient to find the law of the series of which these fractions are the terms. Let $u\,e = p$, $x\,z = P$, and let each be divided into n parts; then in our diagram, we shall have x' 1', 1'—2', etc., each equal to $\frac{P}{n}$ and u 1, 1—2, etc., each equal to $\frac{p}{n}$; also $v\,c = P - \frac{p}{n}$

$$\text{whence } \frac{v\,3}{c\,3} = \frac{\frac{p}{n}}{\frac{p}{n}+P-\frac{P}{n}} = \frac{\frac{p}{n}}{\frac{p+nP-P}{n}} = \frac{p}{p+P\,(n-1)}$$

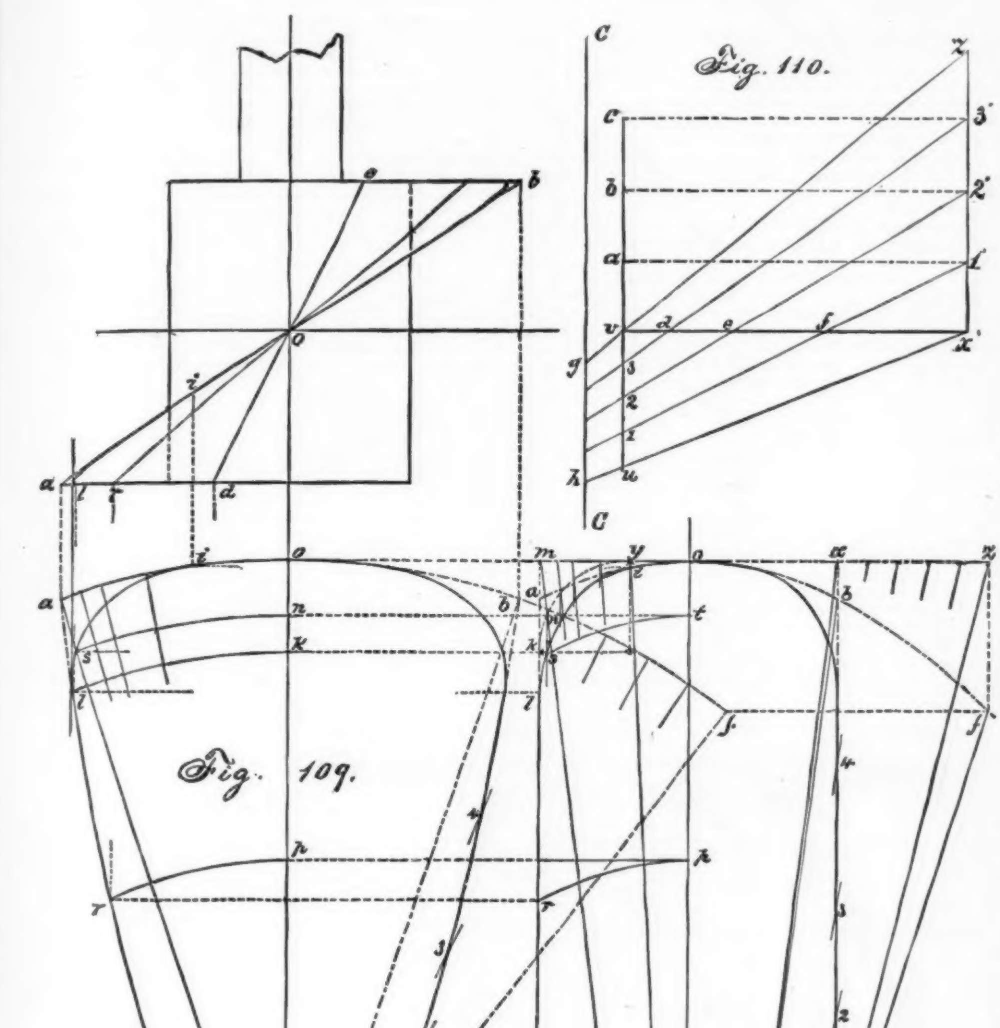


Fig. 109. Fig. 110.

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Now since we know how many times P is greater than p, let $P = m\,p$; then we have

$$\frac{v\,d}{v\,x} = \frac{v\,3}{c\,3} = \frac{p}{p+m\,p\,(n-1)} = \frac{1}{m\,(n-1)+1}$$

and in a similar manner we find

$$\frac{v\,e}{v\,x} = \frac{v\,2}{b\,2} = \frac{2}{m\,(n-2)+2}$$

$$\frac{v\,f}{v\,x} = \frac{v\,1}{a\,1} = \frac{3}{m\,(n-3)+3}$$

and so on.

We see then that the numerators of the fractions on the successive integers 1, 2, 3, etc., and in the denominators we have the same integers, negative within the parenthesis and positive without.

In Fig. 109, the outer pitch being twice the inner, and there being five divisions, we have $m = 2$, $n = 5$, whence we obtain the series

$$\frac{1}{9},\ \frac{2}{8},\ \frac{3}{7},\ \frac{4}{6},\ \text{which are the}$$

fractions of $v\,x$ to be measured outward from the hub on the corresponding radii in the end view, where $b\,f$ is also divided into five equal parts. Had we made ten divisions, we should have obtained the series

$$\frac{1}{19},\ \frac{2}{18},\ \frac{3}{17},\ \frac{4}{16},\ \frac{6}{14},\ \frac{7}{13},\ \frac{8}{12},\ \frac{9}{11},$$

in which the alternate terms are, as they evidently should be, identical with the successive ones of the first series. The law of the series is so simple, that it will very frequently be a great saving of time to calculate the radii in this way, instead of constructing the helical arcs as required by the first method, and the results thus obtained are perfectly reliable, however acute the intersections upon which the second graphic method depends.

Without rounding off the corners, then, our blade will revolve within a cylindrical space, the upper outline of which is $m\,o\,x$, the corner a rising to m. Now let us round off the corner of this cylinder, by a circular arc $y\,k$. The effect of this might also be found by the general method of drawing helical arcs, thus: Any horizontal line as $n\,n$ may be considered as the outline of a cylinder, which cuts $o\,c$, in the side view, in the point t, through which a helix is drawn; this horizontal line also cuts the arc $y\,k$ in n, which in revolving describes a circle, seen edgewise in the side view as the vertical $n\,s$ cutting the helix $t\,s$ in s, the true position of the point which will rise to n as it revolves; and this is projected to s on the corresponding circle in the end view. But here too we may save the labor of calculating the pitch and drawing the helix, by another process, which we illustrate in connection with the same points, n and s; as the point n was in fact found by drawing $m\,w$, the highest revolved position of the element through the original corner a. The corresponding radius in the end view is $C\,a$, which intersects the circle described by n, in the point s, which is then projected to the vertical through n in the side view. The arc assumed is tangent to $o\,m$ at y; a perpendicular through y cuts the helix through o in i, the point at which the rounding of the blade will begin. And $o\,y$ being a known fraction of the pitch, we set off in the end view the arc $o\,i$, the same fraction of the circumference, as giving a more accurate determination than can be made by projecting i in the side view to the outer circle. The other point of tangency, l, is found by drawing the circle described by k, cutting the spiral outline $a\,l\,d$ in the required point, which is then projected to l in the side view. We have in the drawing indicated the finding of one or two other points in the curve $l\,s\,i$ by which the blade is rounded off, employing the method last given, which the reader can readily follow without further explanation; and the leading and trailing edges being perfectly symmetrical, the curves when constructed for one side may be copied on the other by any of the methods previously described. As but a single blade is here drawn, a top view as in preceding instances is added in order to make the representation complete; the construction of this, we take it, will be easily traced by the student, the lettering being made to correspond with the other views. Indeed, the student should be able to manufacture this view for himself, without attempting to study it out from the diagram here given; if he be not, that fact is sufficient proof that he has not thoroughly mastered what has preceded. Which leads us to add, that the best if not the only way to acquire a perfect mastery of this subject is to make the constructions; a mere study of the work of others, or of the description of the methods used, may serve to enter the nail, but it cannot be driven home and clinched without making practical use of what is thus acquired.

ON THE MINUTE MEASUREMENTS OF MODERN SCIENCE.

By ALFRED M. MAYER.

Article XII.

ON THE APPLICATION OF ROTATING MIRRORS TO THE MEASUREMENTS OF MINUTE LENGTHS, ANGLES, AND TIMES.

II.—SAXTON'S REFLECTING COMPARATOR APPLIED TO THE COMPARISON OF STANDARDS OF LENGTH.

THE comparison of a measure, say a yard, with a standard is an easy operation with Saxton's comparator, when we know the value of a scale division in linear motion of the mirror-rod, and when the variation in the position of the mirror for successive contacts of the mirror rod against a bar has been accurately determined.

In making comparisons of units of length, the comparator should be placed in a room in which the temperature is as constant as possible. Such a chamber is a room whose ceiling is under the level of the ground, and is entered by a door near, or even in, the ceiling. This position of the entrance into the room is very important, for, if an entrance be placed near the floor, there will, on opening the door, invariably be a current of air out of or into the room, wherever the temperature of the air outside the room is hotter or colder than the air inside. But with the entrance in or near the ceiling, the air remains in the room, and not being mixed with air of a different temperature from outside, I have often seen the temperature of a similar chamber not to vary more than one-tenth of a degree Centigrade in twenty-four hours.

In this chamber of constant temperature. we put up the comparator and allow it to remain there several days before beginning to use it. The measures to be compared have also been several days alongside of each other, near the comparator, before we commence to compare them. The standard is now placed in the comparator, supported at quarters of its length by springs, as has already been explained in describing Fig. 34, of Article X. After the standard has remained in the instrument several hours, so that we are sure that any heat which it may have taken from our gloved hands has been dissipated, we illumine the scale by means of a lamp which sends a beam of light, through a glass sphere holding water, into the closed room, and read the scale through a telescope placed outside the room.

Several successive contacts are now made by drawing (from outside the room) the mirror-rod away from contact with the standard and then allowing it to come against it. These various readings having been noted and also the temperature of the room, and the height of the mercury in thermometers placed in holes in the beam supporting the comparator, and also the temperatures of the standard and the measure to be compared, we remove the standard as rapidly as possible and place in its stead the measure to be compared with it. A sufficiently long interval having elapsed, we again take the scale and thermometer readings. If these are the same as those obtained with the standard, then the measure is of the same length as the standard; but if the scale readings differ, we take their difference: which number, multiplied by the linear value of a scale division, gives the difference in the lengths of the two measures. If the temperature of the measure should be different from that of the standard, then we must reduce it to the length it would have at the temperature of the standard; and this is readily done if we know the co-efficient of expansion of the bar forming the measure.

Sometimes it is required to compare two units of length, one differing from the other in temperature. Thus, the meter-bar may be a standard at 32° Fahr., while the copy with which we wish to compare it may be a standard at 60° Fahr. There are two ways of making the comparison: either the co-efficients of expansion are first determined, and then the two bars are compared at the same temperature, and their lengths subsequently reduced to what they would be if they had been compared at the temperatures at which they are standards; or, they may be compared by introducing one into the comparator at the temperature required for it, and then placing the other measure in the comparator at its designated temperature.

Of the two methods, I prefer the first, for in the second method a considerable time must elapse before the temperature of the comparator becomes stationary after the introduction of the standard, and hence we cannot rely on the permanency of the apparatus; and, also, the contact of a hot or cold bar with the mirror-rod and abutting screw causes a change of their temperature and an alteration in the length of their bodies, which alone gives a motion to the scale, which is difficult to allow for, and which should be avoided if possible

The manner of determining the co-efficient of expansion of the bars forming the standards will be now explained.

III.—*Saxton's Comparator applied to the determinations of the co-efficients of the expansion of metals and alloys.*—At first sight it appears that Saxton's comparator is not well adapted to the measurement of co-efficients of expansion, for it is an end measurer, that is, an instrument which only measures changes in the distance between the terminal planes of bodies; and it cannot well measure differences in length amounting to more than one millimeter. Hence, to make the comparator serve in the measurement of co-efficients of expansion, we are required to devise an accessory apparatus, which will hold the bar, and heat and cool it, while its terminal planes are exposed, so that the bar can be grasped by the comparator between the end of the mirror-rod and the end of the abutting screw. Such was the instrumental problem which presented itself to me while recently engaged in a research on co-efficients of expansion, and desirous of using Saxton's comparator as the measuring instrument, from special and peculiar advantages which this instrument possesses, and of which we will shortly speak.

A bar may be surrounded with ice or steam up to its very ends, and yet have its terminal planes exposed to the contact pieces of a measuring instrument, by the following simple plan which we have invented, and which experience has shown to work excellently well.

A brass tube T T', Fig. 39, is made about one eighth of an inch shorter than the bar, B, B', whose expansion is to be measured. This bar is supported in the interior of the tube on standards S, S'. Against the ends of the bar, B, B', are two washers of india-rubber *w*, *w'*. In the center of each washer is a hole large enough to allow the ends of the abutting-screw, A, and mirror-rod, R, freely to enter and come against the ends of the bar, B, B'. The india-rubber washers are pressed against the ends of the tube, T, T', by two screw-caps, C, C'. In these caps are circular openings which are larger than the diameter of the bar, B, B'. A spring *r*, *r'*, is fastened to each cap, and this spring carries a ring at its end which presses against the rubber washer and thus, while making it perfectly water and steam-tight, allows the bar freely to expand and contract in the tube, T, T'. The weight of the bar is partly taken off the standards, S, S', by the upward action of the springs, O O', which support so much of the weight of the bar that it slides easily on the standards, S, S'. The tube T, T', is supported on Vs, shown at V, V', of Fig. 39, and better at V, V', in the perspective drawing, Fig. 40.

In Fig. 40, the tube holding the bar to be experimented on is shown at T, T'. This tube is supported in the Vs, V, V'. Its weight is so relieved from the Vs by the action of the spring balances, B, B', that only enough weight of the tube remains to keep it securely in the Vs. The consequence is that, although the tube, containing a bar surrounded with ice, weighs about 14 pounds, yet it can be handled with great delicacy. At *p* and *p'* are seen projecting pins. Springs, one of them shown at S, take hold of these pins and thus pull the end of the bar contained in the tube, against the abutting micrometer screw, shown at A, in Fig. 39, and at S, in Fig. 38. A screw at E serves to rotate slowly the tube in its Vs, so that the bubble of the straddle-level L can be brought into the middle of its scale. Through the tube D can be passed either steam or water into the apparatus; the steam or water finding an egress through the tube C. Tubulars B, B', and B'', perforate the top of the tube T, T', and allow thermometers to be introduced (through corks in these tubulars) into the apparatus. These tubulars also serve as openings into which to pour hot water to melt the ice around the bar.

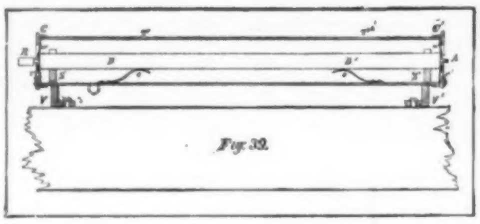


Fig. 39.

The manner of using this apparatus in the determination of a co-efficient of expansion we will now concisely explain. By co-efficient we understand a factor which serves as a multiplier, and the co-efficient of expansion of any metal is that fraction of its length while the metal elongates or shortens by the addition or subtraction of one degree of temperature. This fraction of the length of a given metal bar is expressed decimally, and hence to ascertain the absolute amount of the expansion of any given length of the metal we *multiply* the given length by the above fraction, or *co-efficient*.

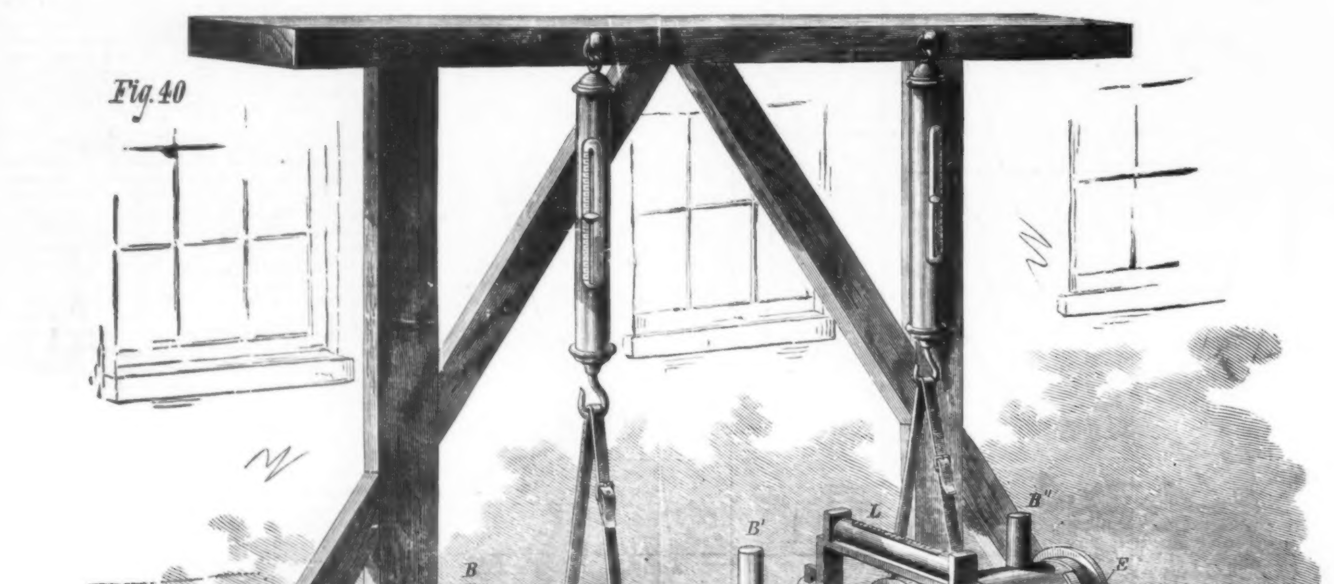
The bar whose co-efficient of expansion is to be determined having remained several hours in pounded ice, is placed in the standards in the tube, T, T', and with soft wooden wedges the bar is held firmly against the bottom and sides of the standards. Finely pounded ice is then packed around the bar. The wooden wedges are now removed, the tube completely filled with ice, and the caps with the india-rubber washers are screwed firmly on to the sides of the tube. The tube with the bar is now placed in pounded ice and there remains for an hour or so. We are then sure that the bar must be at the temperature of melting ice, or 0° C., or 32° Fahr. The buckles are placed in the proper holes in the straps and the latter are put under the tubes and attached to the spring balances. The head of the abutting-screw is placed at a known reading, the springs E are fastened to the projecting pins *p'*, and the end of the bar is pulled against the end of the abutting screw. The screw E is then turned till the bubble comes to the middle of the level. The mirror-rod, *r*, *r'*, of the mirror M has up to this time remained drawn back from the bar in the tube, T, T; it is now allowed to abut against the bar while at that instant an assistant reads off the scale reading in the telescope T, figure 35 of Art. X. The mirror rod is now drawn away from the rod by turning the milled head F, and the springs S having been detached from the pins *p'*, the abutting screw is again set to the same reading, and the spring S again pulls the bar against the abutting screw. Then the mirror-rod is allowed again to touch the end of the bar, and another scale reading taken. This operation is repeated three times.

The tube is now removed from the Vs, and hot water is poured into the tubulars till the ice is all melted. Steam from a boiler is passed through the tube D, around the bar and out of the tube C, during the period of thirty minutes. The tube is now removed to the Vs, the abutting screw set to the old reading, the straps adjusted to the proper hole for the diminished weight of the tube; and all of the adjustments of level, etc., having been attended to, the assistant takes another reading at the instant the mirror-rod abuts against the end of the bar. The reading of the height of the barometer is taken by another assistant at the moment the reading is made of the scale in the telescope. The scale reading has to be rapidly taken, for the hot bar gives up heat to the mirror-rod, and, elongating it, causes a motion in it which has to be subtracted from the scale reading in order to obtain that which the heated bar alone gives.

During the above operations, while the tube is in the Vs, the steam is conveyed to the apparatus by rubber tubes and is constantly pouring through the tube. The tube is now removed from the Vs, and after the steam has passed through the apparatus for fifteen minutes more, another measure of the increased length of the rod is taken. The tube is again removed, and finally a third measure is made after the lapse of another 15 minutes. Every time a scale reading is taken the corresponding barometric reading is noted.

We have to measure the entire length of the rod at a known temperature, say, at 60° or 70° Fahr., and then we have all the means for determining the co-efficient of expansion, or the fraction of the length of the rod at 0° by which the rod lengthens by heating it one degree. For we have the length of the rod at 0°. We have the temperature of the rod when the steam is passing around it, for we know the atmospheric pressure at which this steam is generated, and from Régnault's tables we obtain the temperature of the steam corresponding to that pressure. Subtracting the scale reading obtained from the bar, when it was in the comparator and surrounded by melting ice, from the scale reading obtained when the bar was enveloped with steam, we have for remainder the amount of scale deflection produced by the bar in expanding from the length it has at 0° to the length it has at the temperature of the steam. This scale length converted into linear motion of the mirror-rod gives the actual expansion of the bar in fractions of an inch or of a millimeter.

We have explained the simplest and most obvious method of obtaining a co-efficient of expansion with the apparatus; but the method we have described can be improved upon, as it is open to this objection: We are not sure that the relations of all the parts of the apparatus have remained constant during the interval which elapses between the measure on the bar when surrounded by ice, and the measure taken when the bar is surrounded by steam. Nearly three quarters of an hour elapses between these two measurements, and we really cannot be sure of the permanency of an apparatus which gives such minute measures as the comparator. This difficulty in the way of precise work is removed



PROF. MAYER'S INSTRUMENT FOR MEASURING THE EXPANSIONS AND CONTRACTIONS OF METALS.

by having another tube exactly like T, T′, but containing a brass bar always at 0° by being constantly surrounded with ice. The length of this bar at 0° is very accurately determined by many comparisons of it with a standard. This bar is first placed in the comparator and the scale reading obtained. Then the bar whose co-efficient is to be determined is placed in the comparator and its corresponding scale reading noted. Then after the ice has been melted from around this bar, it is heated up to the boiling point and then it is ready to be placed in the comparator; but before doing so, we again put in the comparator the bar which is always kept at 0° and obtain its scale reading. Then the bar which has remained heated to the boiling point is placed in the comparator and compared with the standard bar at 0°. Thus a bar is compared both at 0°, and at the boiling temperature with a bar which always remains at a constant length by being constantly surrounded with melting ice.

From our determination of the co-efficients of many alloys, we are led to believe that the work done with this apparatus is very accurate.

In a subsequent communication I purpose giving the results of this work on the expansion of metals and alloys.

FIRE SCREENS IN ENAMELED SHEET IRON; FROM DESIGNS OF GIRARD AND REHLENDER, ARCHITECTS, BY R. KITSCHELT, VIENNA.—*From The Workshop.*

FIRE SCREENS IN ENAMELED SHEET IRON.

The sheet iron is stretched between iron pipes, the foot cast iron.

The pendent ornament in Fig. 1 is perforated metal with cast palmettes and drops, in Fig. 2 fringe work.

The colors in Fig. 1 are brownish yellow, white in white and black in black, in Fig. 2 variegated on black ground, the framework and feet gilt.

THE COCHRANE SUIT IN A NUT-SHELL.

THE spirit of the age demands brevity in the discussion of even the most important subjects. No one desires to labor through columns of matter to gain information which may be compressed into a few terse, intelligible paragraphs. It is in conformity, therefore, to this spirit that we shall attempt to present the main points of the great patent suit, which now so interests the milling and allied branches, the discussion of which is beginning to extend beyond even these and is becoming an uppermost topic in legal and commercial circles.

In the year 1863, a patent was granted to Wm. F. Cochrane on an improved flour bolt. This bolt did not appear to meet with immediate favor, or prove signally successful in operation, as it is reported to have been abandoned in the only mill in which it was ever fully tried. But in this patent, references are made to blasts of air in connection with the bolting process. The growing, and consequently almost universal prevalence of the new process of milling, which consists chiefly in the use of blast or suction fans producing currents of air for the purification of middlings, led the patentee to seek and obtain, in 1874, a re-issue, comprehensive enough to cover the art of manufacturing flour by the new process, which had come into such general use. This re-issue grants claims covering the entire process regardless of any special machinery which may be employed to successfully to do the work. Thus were placed under tribute the many hundred inventors, and thousands of millers who had developed into successful machines, or employed in the manufacture of flour, the principles before named.

A law-suit was then instituted in the Supreme Court of the District of Columbia in the name of the patentee against residents of the district, for alleged infringement. In this suit the patentee failed to sustain his claim. The case was then taken to the United States Supreme Court, where the decision of the former court was reversed, and the patentee sustained in his claims. The millers of the country claim and feel that no such defence was made in the Supreme Court as the great importance of the case demanded, nor as millers really interested in maintaining their rights could and would have made.

Upon this latter decision, a stock company was at once organized, for the purpose of collecting tribute from the millers of the country. An injunction was procured against Messrs. J. A. Christian & Co., of Minneapolis, Minn., compelling that firm to give bonds to the amount of a quarter of a million. The same proceedings were instituted against the Haxall-Crenshaw Co., of Richmond, Va.; the Empire Milling Co., of St. Louis, Mo., for one hundred thousand dollars; and the Camp Spring Mill Co., Atlantic Milling Co., and Union Steam Mill Co., of St. Louis, for fifty thousand dollars each.

It is not surprising that, at the appearance of this ominous storm-cloud, the millers were thoroughly aroused. State organizations which had already been formed, discussed the matter and passed unequivocal and condemnatory resolutions; the National Association meeting, at Buffalo, considered the matter fully, encouraged already existing local organizations, and urged the formation of new associations in States yet destitute of such societies. Attorneys were employed, and efforts made to collect evidence from this and foreign countries, looking toward an impeachment of the validity of the original patents as well as proofs of the illegality of the re-issue.

In connection with and growing out of this difficulty, the millers, moreover, urge upon the next Congress, as a general measure, a thorough reform of the present laws and of the management of the patent office, and, as worthy of special investigation, all the facts connected with this particular patent. It is claimed that the investigations, if thorough, should settle the following points: 1. Was the first essential, to wit: *novelty*, sufficiently clear to warrant the office in granting the patent of 1863? 2. Under what influences or inducements did the patent office grant the reissue of 1874 for a totally different thing? 3. What, if any, improper influences or corrupt collusion, by the parties of the suit, were used, and by whom, in securing the Supreme Court decision establishing the validity of the re-issued patent?

The millers of the country are confident that they will have evidence enough to conclusively prove the legal worthlessness of the claims, and regard the latter trial before the Supreme Court as the most remarkable in the annals of history for the perfect good nature, apparently existing on both sides, and the slight effort made for defence. A noted attorney, speaking of these patents, says: "We shall endeavor to prove that whatever of novelty they possess is not meritorious, and whatever merit they have is not novel."

Thus the matter now stands. That the ultimate decision is one of the most vital interest to all classes there can be no question. It affects alike the miller, the manufacturer of mill-machinery, the wheat-grower and bread-eater, and it is fully deserving the earnest attention which it is receiving at all hands.

It is highly important, therefore, for millers to keep fully informed as to what is going on around them, remembering that something more is necessary than simply to denounce the claims; and remembering, also, that courage born of knowledge discounts always, the recklessness which springs from mere contempt of opposition and danger.—*Leffel's News.*

A MUNIFICENT BEQUEST.

MR. ALLEN C. LEWIS, of Chicago, left a will, which, after various bequests to charitable societies and individuals, places the residue of his estate, which is estimated to be worth at least $500,000 after allowing for shrinkage, in trust, to be invested in good paying securities or real estate, and held until 1885, or until such time as $800,000 can be realized out of the trust estate, when the trustees shall erect a building in Chicago, to cost not over $250,000, to be known as the Lewis Institute, in which shall be established a free library, also a night school for the free instruction of pupils in special branches or studies, such as telegraphy and other scientific instruction. A lecture room is also to be built, and a course of free lectures maintained, devoted to arts, sciences, etc., or public readings. Also a free reading room with all late standard newspapers, magazines, and a library furnished with scientific works, avoiding novels and all sensational literature. Also a school for teaching females in such branches of art, science, designs, etc., as may be deemed best to enable them to gain a livelihood from such teaching. And also, as soon as the estate admits of it, to establish and maintain a thorough polytechnic school. This school is to be established in the most thorough and systematic manner, with a first-class corps of teachers, so as to make it one of the leading schools of the country. Scholars are to be admitted, first, from the city, then the State, and, lastly, if there are opportunities, from the country at large, and all free.

THE French have very strict building laws. No flues are permitted in a party wall. They may be built against it, but a thickness of about eighteen inches must remain intact from the foundation to a point some way above the roof.

ROTATING TEETH IN THEIR SOCKETS.

By J. N. FARRAR, M. D., D.D.S., Brooklyn, N. Y.

THIS is one of those little annoyances of the dentist which, according to the old method of operation by the use of ligatures, has led to many disturbances of a psychological nature, which, if they did not take outward form by verbal expression, have often only been suppressed from fear of further undesirable consequences—a condition of mind not in harmony with the laws of digestion or happiness.

Finding great satisfaction, peace of mind, and saving of time, during the past two years, from the use of a few simple devices which may be made to act as powerful wrenches *firmly* affixed to the teeth to be moved, and having calls from dentists for them, it has occurred to me that I would do no more than justice to my co-laborers to illustrate my favorite plans in the *Dental Cosmos*, in order that any person may be enabled to make and use them, if desired. The main points necessary in the successful regulation of teeth are, firmness of application of the instruments and minuteness of the apparatus, in order to facilitate management and secure ease and comfort of the patient. Clumsiness of apparatus is a great stumbling-block to the success of operations as well as the reputation of dentists. The idea of a wrench application is not new, though original with me. Dr. Atkinson has used something of this sort, made after the shape of of an old-fashioned, long-handle dipper, fitted over the tooth, with the handle used as the lever; but this device lacked firmness of attachment—a defect that is fully overcome by my plan.

Figures 1, 2, 3, 4 represent some of the forms of these devices, and the ordinary methods of their application to the teeth.


FIG. 1.


FIG. 2.

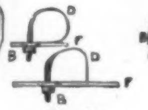


FIG. 3.


FIG. 4.

ROTATING TEETH IN THEIR SOCKETS.

Owing to the presence of the tongue, the box-wrench (Fig. 4) is not so applicable to cases in the lower jaw as the form represented by Fig. 3, but for the upper teeth the box-wrench is admirably adapted, and has a powerful leverage.

The apparatus should be made of eighteen-carat gold, unless it be the screw, which is often more durable if made of brass; but if a rivet-joint be made at A in Fig. 4, the screw may be made of steel. If no joint be made, as is often my custom, soldering the thin gold band to the square head E of the screw—steel will not answer.

The thin band D (Fig. 4) having been placed over and around the tooth to be rotated, it is made to hug firmly to it by being drawn into the square sleeve or box C of the box-wrench by means of the nut B; but in case of the band-wrench (Fig. 3) is used, the same thing is made by drawing the screw through the bar F by tightening the nut B. The box-wrench (Fig. 4) is made to rotate the tooth by the attachment of its extremity to a band of rubber, G, and ligature, O, secured to some tooth, as shown in Fig. 1. The same motion may, however, sometimes be better made by a screw (Fig. 2) rotating in a swivel, K, attached to the wrench and secured to some distant tooth, the screw being made to turn by means of a lever through the eye H, which shortens the screw by its entering the barrel I. These devices are suitable for all sizes of teeth, and may be used for years with care. Devices made upon the principle of Fig. 3 are generally made to act by one end of the bar F resting firmly against an adjacent tooth, while the tightening of the nut, once or twice per day, causes the tooth to rotate. Though generally only one end of the bar F should project from the band, sometimes a double end can be made more useful.

This instrument (Fig. 3) is invaluable for securing teeth in proper position after completing the regulating process, as it can be used, without annoyance to the patient, for any length of time.

LECTURES ON PARALYSIS AND CONVULSIONS AS EFFECTS OF ORGANIC DISEASE OF THE BRAIN.

Delivered at the Bellevue Hospital Medical College, N. Y., 1877

By C. E. BROWN-SEQUARD, M. D., ETC.

LECTURE III.

GENTLEMEN: I have endeavored in the two preceding lectures to bring forward facts which prove that paralysis and convulsions are not due to the causes that are now generally admitted to obtain, by most physicians. I have tried to show that paralysis, instead of being due to a local lesion in a direct way, is caused by an irritation starting at one point and propagated to cells at a distance. The phenomena are not due to a loss of function in that part in which the disease exists, but to an irritation starting from such a point, and carried to other parts at a distance. To take a single instance, the cells of gray matter that serve or are put in action, when the will is exercised to lift the arm. These cells are not aggregated in one particular spot, but are scattered all over the brain, and if loss of power of moving the arm exists, there is a loss of functional activity of the cells that produce it. As they are scattered, destruction of a considerable portion of the brain will not cause a loss of power to produce these movements as there will still be some of this class of cells left able to perform their function. Paralysis, then, is simply a loss of functional activity. It is the same phenomenon as occurs when we produce paralysis of the heart by galvanizing the par vagum. In every instance an irritation starts from the place where the disease is situated, whether it be in the cerebrum or cerebellum, and causes an arrest of activity at a distance. This view is in harmony with all the facts that are observed and explains them much better than any other theory that I know of. A theory, in order to be true, must have all known facts either in perfect harmony with it, or clearly prove the conclusion; and also there must be no fact in opposition with it. Such is not the case with the theories in general acceptance, as I have endeavored to show, but to my knowledge there is no fact yet observed that is in discord with the view I set forth, and it explains all the known facts; it therefore complies with the conditions. Whether I am absolutely right, or the future still keeps in reserve facts which will show my theory to be incorrect, time alone will determine, but at present it offers an explanation for all the phenomena of disease of the nervous system. One series of facts is certainly most evidently in harmony with this theory. I have already said that all kinds of paralyses, of an infinite variety, may follow from brain disease wherever located. I have published many facts, observed by the best and ablest clinical writers in the profession, and not recorded by myself, having carefully abstained from including my own cases, and they have established these points. According to the old theories, a lesion in one half of the brain, no matter where located, could only produce paralysis by being in those parts that are considered as centers of voluntary motion. But there are numerous cases of paralysis due to disease situated entirely outside of the voluntary motor apparatus. If the disease be in the voluntary motor apparatus it ought to produce paralysis in those parts of the body controlled by such portions of the brain, according to the seat and extent of the lesion. Suppose the lesion to be on the left side of the brain, it should produce paralysis on the right or opposite side of the body. Now, it so happens that in at least one in every two or three hundred cases, the paralysis exists on the same side of the body as the lesion. This, then, is the first discrepancy between the facts, and the old theories that attempted to explain them. Again, the paralysis may only occur in one limb on the opposite side of the body, and this fact is a second point. Moreover, the paralysis may appear in one limb only, without the disease being found in that particular portion of the brain, supposed to be the center for that limb. The face can be paralyzed when the lesion is situated at a distance from the supposed centers controlling the action of its muscles. In thirty or thirty-five cases in which paralysis occurred only in the face, the disease was not in that part which has been considered as its motor center. The tongue may be paralyzed on one side only, and that on the opposite side from what it should be. There are a number of such cases published. The tongue alone can be paralyzed, but this happens less frequently than the same occurrence in the face, when there is a lesion above the pons Variolii. This is an extremely important point. This lingual paralysis appears by far more frequently on the same side as the lesion, than does paralysis of the limbs. The muscles paralyzed almost exclusively, when there is a lesion in the spinal cord or medulla oblongata are paralyzed when the disease is in the cerebellum. In such cases associated movements are apt to suffer. Broadbent, of London, attempts to explain these phenomena by the supposition of a common center connected with each side, and capable of being excited by either singly. There is no necessity for such a hypothesis. We may have a lesion on one side of the brain with paralysis of both sides of the neck, or the muscles of the trunk may be affected on one or both sides, either on the right or wrong side. Some of these facts are extraordinary, and there may be an infinite variety of results from a disease in any particular portion.

A lesion limited to one half of the brain can produce a paralysis in the two upper limbs, and the paralysis may be as perfect on the wrong side as on the right. In all of these cases, unless you admit that the autopsy has been badly made, or that all of the lesions were not discovered, you must admit that the theories are wrong. However, it does not prove because we find no lesion that none exists. Our means of exact diagnosis are not by any means perfect, and a lesion that is actually present may possibly escape the closest observation. But, on the other hand, there are numerous cases in which no such doubt could exist. For instance, if a healthy man, who has never had a trace of paralysis, has a sudden cerebral hæmorrhage, which causes paralysis of the two arms, in a short time he dies, and the autopsy is made. We then find extravasation of blood on one side, but never find it in the two supposed centers together. I have searched carefully, and have the best means of knowing, but have never found the record of a single case in which it existed. There are, however, a number of such cases of hæmorrhage that have caused total paralysis of the two arms, and the autopsy has showed a lesion existing only on one side. In such a case, we can not but admit that all the lesions have been seen.

In paralysis of the lower limbs we find the same facts and even more strongly proven. There are many more cases of the class of which we are speaking, of paralysis of the legs than of the arms.

In a number of well authenticated cases, disease in the cerebrum has produced paralysis in the two lower limbs, where it has no business to produce any paralysis whatever, in a portion of the brain entirely outside of the motor apparatus. Paralysis from such a local lesion is impossible, and still less should the two lower limbs be affected. If you call paralysis merely a loss of power, it should never occur in such a case.

As regards paralysis of the lower limbs, a great many cases are on record, but some of them certainly leave some doubt. When paralysis of the lower limbs appears slowly, with loss of power of the sphincters of the bladder and rectum, we usually know that the disease is in the spinal cord. In those cases, then, in which the spinal cord has not been thoroughly examined, there is doubt. But here again the same reasoning comes into play. Suppose we have a case of softening from embolism of the Sylvian artery, with paralysis of the lower limbs, in a healthy man, with no disturbance of the sphincters; if no other lesion is discovered, then the case is clear. It is not likely that any other disease has existed in the cord which was not discovered.

In cases of hæmorrhage in the brain which has destroyed life rapidly, these facts are still more evident. If paralysis of the lower limbs has appeared, it is the most natural supposition that the hæmorrhage caused it. If you say that in some of these cases the examination has not been thorough, or that all the existing lesions were not discovered, I am willing to agree with you, but it is then reduced simply to a question of the number of cases. You can not in every case say that there was another cause for the symptoms.

The nervous system is a whole, a unit, and not a system of different parts or centers simply connected together. It may be put into play throughout its whole extent at once. The whole of it may be called into activity by a single movement, as the mere lifting of the arm, and all the facts that I have related at length show that an irritation in any one part of this system will cause a change to take place at a distance, by propagation. There are many strong arguments against the theory that loss of tissue, or disease, in any one part of the nervous system will cause a special paralysis.

Now, to pursue this line of argument still further, not only can we see the two lower or the two upper limbs paralyzed together, from disease of one half of the brain, but we may see three limbs affected. It may be the two legs and the right arm, the two legs and the left arm, or the two arms and the right or left leg. It may be said that some lesion remained undiscovered in these cases, but the same reasoning given in former cases may be applied here with equal force.

We may likewise find a great many other kinds of paralysis. There is a form in which the face is paralyzed on one side, and the body on the opposite, due to disease in the pons Varolii. This was termed "*paralysie alterne*" by my friend Dr. Gubler, of Paris. Now, with this kind of paralysis, the disease may be situated in other parts of the brain, as the corpus striatum on one side. I have published a number of such cases. This is a fatal objection to the admission of the old theories, to have disease of the left corpus striatum with paralysis of the face on the same side, and of the limbs on the opposite. If you are not aware that such a thing may occur you will in many instances make a false diagnosis. The diagnosis bears greatly on the treatment and prognosis, and if the one be false the others would be wrong. A difference in diagnosis would make great alteration in the prognosis especially, for usually a disease in the pons Varolii is much more rapidly fatal than disease in many other portions of the brain.

What I have said of the face is true of the tongue and eye. There is a kind of alternate paralysis of the tongue as well as of the face. If the third pair of nerves is paralyzed, the muscles of the upper eyelid, as well as some of the internal muscles of the eye, will be paralyzed. All the muscles, except the external rectus and the superior oblique, will be unable to act. Cross paralysis of this kind occurs, and there are two or three perfectly clear cases. This certainly is a deadly blow to the old theories.

The diaphragm may sometimes be paralyzed, when the lesion is very high up in the brain, above the origin of the phrenic nerves, and there is no lesion lower down.

There are, moreover, muscles not altogether under the control of the will which are very frequently paralyzed from disease of the brain, and these facts are likewise exceedingly favorable to my views. There are certain muscular actions that take place only under the influence of reflex action, among these is the process of deglutition or swallowing. In certain cases the œsophagus can not perform its functions properly, when the reflex power of the cord is paralyzed by some disease.

The same thing occurs with the sphincters of the body, as those of the rectum and bladder. It is not rare in such cases that, instead of there being difficulty with the retention of the contents of these viscera, there is difficulty in voiding them. These phenomena usually occur in disease of the spinal cord. Now, in certain cases of brain disease, where the spinal cord is in an apparently normal condition, we find paralysis of these sphincters as well as of the œsophagus.

It may be objected that a lesion of the spinal cord has escaped observation, but the objection is answered in the same way as in the previous instances. The true statement of the facts is this,—that disease of the brain produces an arrest of activity in the cells of the medulla oblongata in the case of the œsophagus, and in the lower part of the spinal cord in the case of the sphincters of the rectum and bladder. An inhibitory effect is produced on these cells. In these facts there is strong proof that a clear inhibition or arrest of activity in the cells of the spinal cord can be produced by disease in the brain. Now, we have still stronger evidence of this fact, because in experiments on animals it is more plainly seen and leaves no room for doubt. If we cauterize the surface of the brain with the actual cautery, we frequently get loss of power of the sphincters without any lesion of the spinal cord that can be discovered by careful inspection and microscopic examination.

Now, if you try to examine closely the new views, you will find that all these facts are in perfect harmony with them. It can not be otherwise; and it must be that when there is paralysis of both sides of the body, where the lesion is situated only on one side, an irritation is carried from the place of the lesion to the other side.

Now, if we turn our attention to hemiplegia and look carefully into its history, we shall see all these facts still further substantiated. There is no complete hemiplegia ever existing alone. I have never in all my experience seen a case of complete hemiplegia without there being some paralysis on the other side of the body. This fact is chiefly noticeable in the legs. There seems to be, from a lesion in one half, an influence exerted on the other side. There is only a difference in degree between the two sides of the body; one side is paralyzed more than the other. If you ask the patient to stand on the sound limb, he can not do it well, and simply from the weakness of the limb alone; from no other cause does it arise. You might say that the force or power itself is not altered, but that the patient's inability

to perform the act arises from the muscular sense being affected. This, however, is not so. This objection can be obviated by testing the power of the limb in other ways than by standing on it. I have tried the power of the limb in other ways, and have found without doubt that the force itself is lost to a certain extent. There can be no reason for a diminution of power, unless there was a transmission of irritation to the other side from that on which the lesion occurred.

A second point is this, that, however various the causes of hemiplegia as regards its nature, seat, and extent, the same group of symptoms usually occurs. No matter where the lesion be situated, in most cases, after the recovery from the first symptoms takes place, the patient has a much more complete paralysis of the arm than of the leg. There are, however, exceptions. There are three muscles of the face coming to the angle of the mouth that are usually affected with paralysis in these cases. This is the typical form of paralysis in brain disease, and we usually find it the same, no matter what the nature, seat, or extent of the lesion. These facts, then, form a strong argument against the view that paralysis depends on a loss or destruction of either the centers of will for the muscles involved, or of the conductors. If such were the case, we should be obliged to admit that centers are located in different places in different individuals. The almost uniform type of hemiplegia exists with a very great variety of diseases.

A third point is that, in a minority of cases a great variety may exist, according to the seat, nature and extent of the causal lesion. We may find the reverse of what is supposed to be true, a paralysis appearing on the same side of the body as the lesion. On the other hand, there are some cases in harmony with the old view, but not in discord with the new one, and I am glad it is so, in order that there may be some excuse for the vast number of physicians who still adhere to it.

Again, as regards hemiplegia, it may appear and disappear, although the lesion that produced it is constant.

How can you reconcile the idea that paralysis is owing to the destruction of tissue with the fact that, while the very same destruction persists, the paralysis disappears? You may say that there are changes in congestion and circulation taking place in the diseased portion of brain tissue, but suppose that both the frontal convolutions, supposed centers of motion for the arms, are entirely destroyed, even in these cases the paralysis may be intermittent. It may act in the same way as a malarial fever. Certainly in such a case the fact is a final death-blow to the old theory.

Hemiplegia can sometimes be cured, and sometimes it disappears suddenly of its own accord. In this fact, also, we have clear proof that we should set aside the old views that paralysis is due to a loss or destruction of centers or conductors.

PHOTO NOTES.

THE *Mittheilungen* says its experience during the last stormy summer days does not bear out Herr Ott's opinion that reticulation of the pigment film of carbon tissue is more likely to occur in the time of storm than at other times.

The same journal gives an account of an experiment made to ascertain the shrinkage or expansion of various sorts of photographs. Six prints were made by various processes from the same original, and when dried and trimmed they all measured exactly 147 × 100 mm.; they were then coated with a starch paste and found to have expanded as follows:

	In length.	In breadth.
A steel blue picture	1 mm.	2 mm.
A uranium "	2 "	0 "
An aniline "	1 "	0 "
A carbon print, single transfer	1 "	0 "
A carbon print, double transfer from glass to paper	½ "	0 "
An ordinary albumen print	3½ "	0 "

All the pictures were finished upon Rives paper. The direction of the sheet was not previously determined. From these results it would appear that silver-albumen prints expand most and carbon prints least, thus confirming the opinion previously expressed by Herr Oscar Suck.

Baron Von Stillfried says that in Yokohama, Japan, he carries on his business almost entirely with the assistance of natives, each one of whom is only instructed in a special department—as, for instance, to polish plates or to sensitize papers—and knows nothing whatever of any other part of the work. At first he used to show his one assistant all the different photographic manipulations necessary to produce a picture, and the consequence was that he soon left and set up on his own account. The rate of wages varies from three to twelve dollars per month. The latter sum is paid to the best retouchers only. Portraits Herr Von Stillfried only takes occasionally, his chief dependence being upon landscapes, which are bought in quantities by European travelers. There are many native photographers in Japan. These conduct their business in the most primitive manner. They have only one small portrait lens, of the cheapest sort, with which they only take *cartes-de-visite*. They do not require to varnish their negatives, but print them right off, as a larger edition than two copies is seldom required. The negative is then washed off, and the glass serves for the next comer. One of these photographers seldom possesses more than three glasses.

From the *Moniteur de la Photographie* we learn M. Boivin's results of experiments made with Kennett's gelatino-bromide pellicle plates, prepared by M. Durand, of Saint Etienne. They were found perfect in all respects. The view selected was a country scene full of verdure, and was taken in ten seconds. M. Boivin considers that the process possesses great advantages, the drying of the plate being the part which is most delicate. It should be done sufficiently quickly, but so as not to allow ridges to be formed on the plates. They must be placed in a horizontal position with great accuracy, for without this care the films will be unequal in thickness. Also in preparing the places it should be observed that rainy and moist weather interferes with the drying. M. Boivin finds the gelatino-bromide to have also great advantages in being so much more rapid than the emulsions made with collodion, seconds only being required with it where minutes are necessary with well-known emulsions. M. Boivin says that in respect of M. Chardon's emulsion he had received for experiment a sample from M. Fleury Hermagis, and found it excellent in all respects, although slow in action and high in price. He had obtained good plates by giving exposures of three to six minutes, where under the same conditions thirty to forty seconds only were required by another process.

M. Terpereau, of Bordeaux, forms screens of taffetas with yellow gum upon sheets, and these are placed one upon the other like scales, and tested by sensitive papers until the chemical rays do not pass. In this way the light can be regulated cheaply and efficiently for the dark room.

WE have received a letter from our esteemed *confrère* M. Léon Vidal, with two specimens of photochromy obtained by the agency of the Woodbury process. He says that, after very long and delicate experiments, he has obtained photochromic proofs from the photoglyptic press with such success that the reproduction is absolutely perfect. M. Vidal considers the improvements of obtaining photomechanical plates so complete that they can be produced at commercial prices, and may form a new industry. One specimen represents an enamel, *Gaston de Foix*, which is surrounded with *repoussé* work in silver, and M. Vidal considers the reproductions of colors and metallic effects among the most interesting applications of photography. Another subject, *Marguerite de Valois*, is an example of the reproduction of the effects of fine metal work. Speaking of the impression made by these works upon the public, M. Vidal states that a rich financier, M. D. Rothschild, said that application need not be made for permission to copy any of the art-treasures of his cabinet, as these reproductions were such as to make him jealous of their being made too common by photochromy.—*British Journal of Photography.*

AERIAL PHOTOGRAPHY.

WE have lately heard of several schemes for the accomplishment of aerial photography, and although we are not at the present moment at liberty to mention the names of the gentlemen engaged in the elaboration of these instruments, nor their precise nature, we have reason to believe that already one apparatus of the kind has been perfected, and is ready for trial. The object of the instrument in question is to do away with the aeronaut, and produce pictures in a camera floating in the air, which are developed on falling to the ground. The raising of the camera into the air, the opening and shutting of the dark slide, and safe conveyance of the apparatus to the ground again are the problems to be solved, and these, we hear, have been satisfactorily combated by two skillful experimenters already.

The apparatus is more especially for use in warfare, for reconnoitering purposes. Balloons that would carry up an operator and his apparatus would doubtless be the most satisfactory way of securing aerial photographs; but since the equipment of these monsters in the field is a source of great difficulty, the new apparatus is intended as a substitute. That anything of the kind in the least degree successful would be warmly welcomed by an army in the field there is no room to doubt, for during the last fifty years military engineers have been engaged with the matter of ballooning. In Bulgaria, just now, such an apparatus would be invaluable to the Russians, who seem to lose sight and touch of their enemy for days and weeks together sometimes. The *Daily News* special correspondent remarked but the other day upon the ridiculous circumstance that "a force of twenty thousand of the enemy can disappear and be entirely lost for some days, when they have in reality only retired a few miles, and have posted themselves in new positions like the old ones. This is, nevertheless, an event of very common occurrence with the Rustchuk armies. The conformation of the ground is well adapted to the easy concealment of small camps, and even of the movement of troops, for the country is undulating, and everywhere there are large tracts of a small growth of oak trees crossed by frequent paths and practicable for cavalry and light artillery. So that by reason of being unable to take an observation a few feet from the ground, the Russians have remained in total ignorance of the whereabouts of their enemy. In fact, they do not seem to know as yet whether the army lately commanded by Mehemet Ali consists of twenty thousand men or one hundred thousand. Yet the fixed ascent of a balloon would have told them this a long time ago, while a photograph, secured in an instant, would have mapped out the enemy's positions in a trice." To show what a slight elevation is required to afford the necessary information, the same special correspondent says: "Two miles beyond the village we came out on an open field, and there lay before us a panorama of the whole Turkish encampment miles away, extending along the further side of the valley."

If any of our clever experimenters can, therefore, manage to devise a practical aerial camera, they may rest assured there will be no lack of patronage just now.—*Photographic News.*

IMPROVED NEGATIVE RETOUCHING.

By G. FRANK E. PEARSALL.

In giving freely to the fraternity the results of my recent studies on retouching, my only object is the elevation of photography by more truthful work. Having taught several who are now holding responsible positions as negative retouchers, I am encouraged to believe that what I am about to offer will be found by all who adopt it a very great advantage; and if those who may receive any benefit will simply acknowledge it I shall be amply repaid, for by so doing they will command the attention of those among us who are loth to try anything new. Great difficulty has been experienced in acquiring a perfect knowledge of retouching on negatives from the falseness of the light transmitted through the image by the *ground glass screen*. It matters not how fine it may be ground; it is but a roughening of the surface, forming numerous little cells each one producing a minute lens, which throws a different angle of light, not only dazzling and affecting the eyesight but confusing the judgment, making it very difficult to critically estimate the value of any touch, and often causing the negative to be very much overdone, as one false touch, being inharmonious, necessitates so many more that the likeness is generally destroyed.

To overcome this uncertain and, as many claim, hurtful labor to the sight, and make it a pleasant, intelligent work, discard the *false ground glass screen* and substitute for it a washed iodized plate. Every photographer can make one of the screens for his retouching frame by coating a glass as for a negative; when ready to remove from the bath, place under the tap, *wash well* and varnish, placing it in the frame with the collodion side from you, to prevent its being scratched. This will give a perfect and true screen; its peculiar opalescent character will offer the most critical examination of a negative when placed behind it; and viewed by transmitted light, as it were, the two films seem to amalgamate and closely resemble a negative before fixing. A soft, delicate, steady light is secured, resulting in no injurious effects to the eye, revealing most perfectly all the detail in the deepest shadows, with an additional advantage which the artist has of a perfect plane to work upon, all parts of the image appearing at an equal distance. This is not the case with ground glass, in which all shadows or transparent parts, when placing the pencil point upon them, seem to recede, leaving only the ground surface to the view, and therefore making it quite impossible to discover any detail in the deepest shadows. This fact can easily be demonstratd by viewing a negative first with a ground, then with an iodized screen behind it.—*Anthony's Photo. Bulletin.*

LICHTDRUCK WITH WATER COLORS.

UNTIL now it has been generally believed that only fatty inks are repelled by the more or less wet gelatine surface of lichtdruck plates, and, therefore, that these inks only are suited for lichtdruck printing. In the year 1869, however, the circumstance that a very thick solution of gum, dextrine, or starch, which at once adheres or sticks fast to any dry body it may be allowed to come in contact with, does not adhere to one's fingers when wet, yet shows a tendency to stick, suggested to me the thought that perhaps only the dry shadow parts of the lichtdruck plate would take on a very thick ink (of about the consistency of lithographic ink) composed of gum arabic, a pigment, and a very little water, while the lights of the picture, being wet, would repel the ink in the same way as it does the fatty ink.

The correctness of the idea was substantiated by my first experiment with such an ink. The pictures printed with this ink from lichtdruck plates, with either a smooth or granular surface, are in no respect inferior to those printed with varnish color, and have not faded in the least since 1869. This phenomenon—that solid or thick adhesive substances do not adhere to less solid or fluid substances, but the reverse—is based upon the fact that the separate atoms in a thick solution hang together more firmly than in a thin. A thick solution of gum arabic, diluted with a very little water or glycerine to about the consistency of lithographic chalk ink, will only leave behind it a considerable number of the atoms which compose it when the connection between the molecules composing the object upon which it is rested is greater and more solid than that of the solution itself. If, on the contrary, it be placed in contact with a more fluid body; being itself the more solid it will carry off a certain portion of the fluid. Also, when similar substances, but which differ in solidity, come in contact with each other, the same phenomenon may be observed. Thus, if a thick fatty ink be placed in contact with a quantity of the same ink to which more oil has been added, the more solid of the two absorbs and carries off a portion of the more fluid.

If one dip one's forefinger into some thick ink and then press it against the thumb, half of the ink will be found to stick to each finger. But if the thumb have been previously dipped into water (if the ink experimented with be thick water-color), or into oil (if an oil-color be used), then by simple contact and pressure no color will be left on the thumb until after the ink upon the finger has been thoroughly mixed by rubbing with the more fluid matter upon the thumb.

It is upon the foregoing peculiarities of affinity of solid for solid that the production of water color impressions from lichtdruck plates is based. The ink used for this purpose should contain very little moisture, nor should there be so much coloring matter as to counteract the adhesive power of the gum. The advantages offered by the use of water colors in lichtdruck are considerable, and demand investigation.

Since the ink only contains water and glycerine in the shape of moisture, but no oil, varnish, or resin, the ink cylinders themselves moisten the gelatine film of the printing plate while blackening it, so that no other damping seems to be required, and every intermediate manipulation is rendered superfluous. My experience has been that up to a hundred impressions may be pulled one after another without the plate requiring to be separately damped, and it may be assumed with a considerable degree of certainty that the number might be yet further increased.

The damping has given rise—even in the case of the lithographic Schnell press—to many difficulties, and has greatly complicated the arrangements of the press, so that the productiveness of a lithographic Schnell press is not equal to that of a cylindrical letterpress Schnell press. But let the necessity of damping for lichtdruck be wholly done away with, then a Schnell press of much simpler construction might be introduced, and thereby a great advance would be made by this lichtdruck process.

Every experimentalist is apt to let himself be carried too far by his sanguine hopes, and often finds quite unexpected difficulties come in his way. Here, however, there was nothing to mislead me, except, perhaps, the single circumstance that the whole number of impressions I have pulled without damping has never exceeded a hundred (because I had not only to make all the experiments myself; but even when doing the actual printing at the press I had no assistance, nor was there any within call). But he who would produce his lichtdruck in this way, and thinks of getting special presses made for this purpose, would require to be sure of getting two or three hundred impressions from a plate without damping before it would be worth his while.

Another advantage of this method is that the color does not spoil the stand nor the cylinders, nor does it, like varnish color, require to be scraped off next morning. If the ink become somewhat dry it may be made usable with glycerine. Then the color dries very little upon the stone; while the prints are pretty dry when they come out of the press, as the paper absorbs the glycerine. The disagreeable exhalations caused by the use of oil of turpentine, so indispensable when printing with varnish colors, is quite done away with, and the stone, the rollers, the knife, and the hands can all be quickly and easily cleansed by that cheap purifier, clean water.

The printing plates for use with water colors are prepared in the usual manner; but very fine prints may also be obtained from plates perfectly free from grain, since the ink feeds textureless plates as well as granular plates with its moisture by rolling. If it be possible to fasten the gelatine film in an elastic living band, as in Despaquis' lichtdruck Schnell press, then my water color ink is eminently suited for printing it. The same rollers that are used for varnish colors may also be employed for water colors, only for some days before being used for the latter they must be frequently coated with glycerine until they cannot absorb any more.

To prepare his ink, which we shall call "water color ink," proceed as follows: Take three parts of gum arabic and add as much water as will produce, after standing twenty-four hours and frequent stirring, a very fine solution, which filter through rags. Then add two parts of glycerine, and evaporate the mixture until white fumes appear. The latter are an indication that no superfluous water is present, but that already the glycerine is evaporating, though not burning. In this condition the gum, which appears a tough and viscous mass, may be kept without spoiling for years, and may

be used as an addition to any given pigment, just as oil or varnish is employed. The best pigment is the finest lamp-black and a little *caput mortuum* (of the dark violet kind). This coloring matter, previously rubbed down with water as finely as possible, is added to the above described gummy mass and well mixed with it with a pestle. The superfluous water is then evaporated off by stirring the ink with a knife upon a hot piece of sheet iron until white fumes rise. When cold the ink is very solid, and may be diluted according to taste with glycerine.

It is not easy to determine the proportions by weight of the coloring matter to the gum, as these vary according to the kind and properties of the coloring matter, and must be specially ascertained for each sort employed; but the dose may be determined by certain signs, namely, the ink must give sufficiently powerful shadows; if these are too weak, even should the ink be rather solid, more coloring matter must be added. Should the adhesiveness of the gummy mass be interfered with by the addition of too much coloring matter, then a little more gum must be added. In this way the proportions of any desired coloring matter to the gum may be determined in numbers.

If a lichtdruck plate is to be printed from in water colors, it should be damped, as usual, with water and glycerine, or that mixture may be poured over the plate. In a few minutes, when all the parts of the gelatine plate shall have become sufficiently moist, the solution should be wiped off, and glycerine alone, without addition of water, must be poured upon the plate and left a quarter of an hour, after which it also should be wiped off. The plate is then perfectly prepared for printing purposes.

To facilitate the blackening, cut off a piece of the ink, moisten it, and rub it over the stone, and then roll it well. The first blackening of a lichtdruck plate gives no good results. The rollers, as well as the gelatine film, which have been previously soaked with glycerine, contain too much moisture, which they impart to the ink, and the ink, thus become too thin, covers every part of the gelatine picture. The first two or three prints (which are made upon dry paper, partially absorbing the superfluous moisture of the film), are very flat, without either depth or high lights. But if the operation be repeated once or twice, and each time fresh, solid ink be used, the time will come when the moisture of the ink, the rollers and the gelatine film will all be suitably proportioned, and when the prints will appear with the proper lights, depth and quantity of ink. From that moment damp paper must be used for printing upon, as the gelatine film can no longer spare any moisture to the paper. By using dry paper the gelatine film might be dried up until the ink should stick fast over its whole surface, and would leave a deep black smear on the whole print. Should such a thing happen by accident it is only necessary to roll longer than usual; the gelatine film will then gradually take on fresh ink, and at last the picture will be developed in all its details. From that time forward it is possible to go on printing without any intermediate manipulation, all that is required being to ink and to pull.

When the ink is of the proper consistency, and goes on to the rollers smoothly, the work proceeds much more rapidly than by the ordinary lichtdruck processes, and one gets very clean prints, which in beauty and appearance are in no respect different from those produced by varnish ink. Also, these water color prints, though finished and ready for use, whenever they come from the press, may, like ordinary lichtdrucks, be further glazed and mounted if desired.

If the gelatine solution have a third part of alcohol added to it it may be transferred without any pencil work; but if one prefer to place the pictures in the gelatine solution, as in a bath, then the alcoholic addition may be omitted. When the stratum of gelatine is dry the glaze is produced by pouring the varnish (particularized in Herr Husnik's book) already described over the pictures in the neighborhood of a warm stove.

Whether the pictures are varnished or not, they are as permanent as the ordinary lichtdrucks, and withstand even damp without fading. If, however, one rub continually at one place with a wet finger pressing upon the picture, then the color gives way. But such treatment no prints could withstand, for the paper itself would suffer, especially if it were chalk paper; so that, on the whole, a water color print is no more liable to injury than a varnish color picture.—J. HUSNIK, *Photographisches Archiv.*

IMPROVEMENT IN CARBON PRINTING.

COLLODION has been used in connection with carbon printing in such varied forms as to render it difficult to pronounce at once upon the precise amount of importance to be attached to another and alleged new application of this substance. Very slight variations in its mode of application may, however, make a considerable difference in the results; and in this light we are pleased to see more methods brought into the field of practice, assured that if by the test of practice they prove to be valuable they will be generally adopted, while if they fail as respects utility they will come to nought.

This is our impression in introducing a new patent, entitled "Lambert's Improvements in Production of Carbon and other Photographic Pictures." The patentee in this instance is not the French gentleman whose name is now so well known in connection with a particular kind of carbon print, but Mr. Henry Lambert, of Bath. When summarized the process is as follows:—A sheet of carbon tissue, previous to its being sensitized, receives a coating of a plain collodion containing a certain proportion of Canada balsam. This is allowed to set or become dry, after which the tissue is sensitized by immersion in a bath of a solution of bichromate of potash. When it is once more dry it is printed upon from a negative in the usual mode, and thereafter is immersed in hot water, and the development allowed to proceed without any other support than the balsamed collodion. The development being completed the pellicular print is first washed in a solution of alum, and is then, and while still wet, transferred to its final support, which the patentee prefers to be a white or tinted enamel card, made waterproof by collodion or varnish and sized with gelatine, although opal, china, glass, paper, or other material may be used for this purpose.

Having thus stated in brief the nature of Mr. Lambert's invention, we now come to the details of the process; and in giving them we make use of the *ipsissima verba* of the patentee:—

"I take a piece of tissue on which a photographic picture is to be printed and coat it with a permanent transparent support in the following manner:—The tissue may either be made sensitive to light by being immersed in a bath of bichromate of potash or ammonia, as is well understood, before or after the permanent transparent support has been applied to it. In applying the said support I lay the sensitized or unsensitized tissue upon a flat surface, the face of the tissue being upwards. I take a piece of cardboard a little larger than the piece of tissue to be operated upon. I cut from this cardboard a piece nearly equal in size to the tissue, the cardboard from which the piece has been so cut constituting a flat frame. I gum one side of the inner edge of the cardboard frame to the extent of about one quarter of an inch, and then place it, together with the central piece which had been cut from it, upon the tissue, the gummed frame lying upon the marginal portions of the tissue, and the central piece of cardboard or that part which had been cut away from the cardboard frame lying upon the other portion of the tissue. The whole is exposed to pressure until the cardboard frame is firmly attached to the tissue. I then remove the central piece of cardboard, and the tissue, with the cardboard frame gummed to its marginal portions, constitutes a very shallow trough into which I pour the permanent transparent and flexible support, the bottom of said trough consisting of the surface of the tissue. When by the evaporation of the solvent the transparent flexible support has become dry or hardened the tissue is sensitized (if it has not been previously sensitized) by a solution of bichromate of potash or ammonia in the usual way. The cardboard frame which forms the sides of the shallow trough is cut away; that is, the bottom of the trough consisting of sensitized tissue coated with the transparent flexible support, is cut of the cardboard frame, and may be cut to sizes required for printing. The printing on said tissue is effected in the ordinary way from glass or negatives. On removing the impressed tissue from the printing-frame I immerse it in warm water to which a little ammonia has been added (two drops of ordinary commercial solution of ammonia to twenty ounces of water answers very well), and develope the picture by the said warm water without any other support besides the permanent transparent support. When the development of the print is completed it is washed with a weak solution of alum and I transfer it with its support to its final mount without waiting for the print to dry.

"In order to mount the print I take a piece of glass or white cardboard of larger size than the print, and I pass the said piece of glass or cardboard under the print immersed in the water. I lift the print out of the water on the said piece of glass or cardboard with its surface or developed side upwards, and I place it in a dish of clean water; but in doing so I invert it—that is, I turn the surface or developed side downwards—and so let the print float off the glass or cardboard, the permanent transparent support being uppermost. I then take the final mount and pass it under the print in the water. I adjust the print to the required position on the mount, and then lift the said mount with the print upon it out of the water and allow it to dry on the mount. If the print when lifted out of the water does not lie quite flat on the mount it may be made to do so by gently passing a soft camel's-hair brush over it. The process is now completed, and the print is seen on the mount with its true or non-inverted aspect with either a glazed or dead surface, according to the kind of mount used. For the final mount or support I prefer white or tinted enamelled cardboard made waterproof on one side by clear varnish or normal collodion, or other transparent waterproofing material. I prefer to size with gelatine that side of the cardboard on which the print is to rest. I do not, however, limit myself to any particular method of mounting the print, as it may be mounted on various substances, for example, as opal, china, glass, paper, plaster of Paris, or ivory.

"The permanent transparent flexible support does not leave the tissue during sensitizing or developing, or afterwards, but remains a permanent part of the finished picture. There is no danger of the blistering or reticulating of the tissue, which commonly occurs in the ordinary method of using it. It will thus be understood that I do not use any temporary support whatever during the developing and mounting of the print, such as is required in the ordinary method of developing carbon or permanent photographic pictures. It may, however, be sometimes convenient to pass a piece of glass or cardboard under the print during the course of development, in order that the development may be the better observed and stopped at the proper time. The use of a piece of glass or cardboard passed under the tissue in the water also facilitates the removal of the back or paper part of the tissue. But I wish it to be distinctly understood that these uses of glass or cardboard, although sometimes convenient, are not necessary to the practice of my invention, and that when glass or cardboard are used as described their function is in no respect analogous to that of the supports required in the ordinary method of developing carbon or permanent photographic pictures.

"When it is wished to have a dead or unglazed surface to the print I prepare an enamelled or white card by coating cardboard with collodion thickened to the required degree with zinc white or other permanent white pigment. The card covered with the pigmented collodion is allowed to dry. The print when mounted upon this card has a dead or unglazed surface. In place of zinc white, finely-ground starch may be added to the collodion with the like effect.

"The permanent transparent flexible support hereinbefore referred to is composed as follows:—

Canada balsam	6 drachms.
Caster oil	1 ounce.
Turpentine varnish	1 "
Plain collodion	70 ounces.

These are mixed together and thoroughly incorporated by agitation, and when the mixture has cleared, either by subsidence or filtration through cotton wool, it is fit for use. If the tissue is to be made sensitive to light after the support has been applied to it, then the turpentine varnish must be omitted, the composition of the support remaining in other respects the same. I do not, however, limit myself to a permanent transparent flexible support of the above composition, but I have found the above composition to answer well in practice.

"Having now described the nature of my invention, and the manner in which the same is to be performed, I wish it to be understood that I do not limit myself to the precise details herein described, as the same may be varied without departing from the nature of my invention; but I claim as my invention the improvements in the production of carbon and other permanent photographic pictures hereinbefore described; that is to say, coating sensitized or unsensitized tissues used in the production of carbon and other permanent photographic pictures with a permanent flexible support on which the tissue is supported during the printing, developing, transferring, and mounting of the picture, whereby the temporary support ordinarily used is rendered unnecessary, and the production of the said carbon and other permanent photographic pictures much facilitated, substantially as described."

In noticing the special claim thus made, and in which lies the whole pith of the patent as a patent, it may not be out of place to remark that the use of collodion film as a support for a carbon picture during development had been suggested by other experimentalists some considerable time back. This speciality, for example, was directly spoken of sixteen years ago by M. Ernest Lacan, our then Paris correspondent, who, in alluding to a process by M. Fargier that he had been describing (see the number of this Journal for June 15, 1861), says:—"The difficulty offered by the manipulation of a collodion film floating in a bath, and which must be, so as to speak, fished out before it can be mounted on the sheet of paper, limits the application of this method, which cannot, in its present state, answer the requirements of printing on a large scale." We are quite well aware that the process of Fargier and that now described differ in several very important respects; but it is curious and a little unfortunate that the special claim made on behalf of the latter patent should bear so close a resemblance to what had been previously done. Again: in giving (September 9, 1870) a description of a new carbon process by Mr. William Firling, we made special allusion to the Fargier process in the following terms:—"As a double transfer process the coating gelatinous film with collodion *as a support during development*, and the subsequent floating of this film upon gelatinous or albumenized paper, was undoubtedly perfect, though the mechanical difficulty of handling the collodion film was so great as to limit its use to a few experts."

We have made these extracts without desire to invalidate the patent, but only to show that the leading feature in the claim had long ago, and more than once, been recognized.—*British Journal of Photography.*

VIOLET SUPPLEMENTARY LIGHT.

OUR readers are familiar with the claims recently put forward by Signor Scotellari, an Italian photographer, to the effect that a certain tint of violet light was more efficient in photography than white light, and that studios glazed with glass of the proper tint gave more rapid results than those glazed with colorless glass. In noticing his claims, we pointed out that the colored light in question was one of the components of white light, and that, unless a part could be greater than the whole, there could be no advantage gained in using it. S. Scotellari was at all times so definite and earnest in his affirmation of the practical advantages gained, and was supported by the testimony of practical men of position and reputation, that we could only with propriety admit that practice in photography had so often been in advance of theory there might be something in it. When we learnt the other day that a firm so shrewd and practical, as well as enterprising, as Marion & Co. had accepted an agency from S. Scotellari to introduce his method, we called with pleasure to meet that gentleman, and hear and see more of the matter. The form in which he now presents violet light as an accelerator may be accepted without scruple or hesitation by any one. It is not as a substitute for white light in illuminating the sitter, but as a supplementary auxiliary in the fashion which diffused white light has been recommended and used with success. S. Scotellari now uses a lens cap in the end of which is a disc of violet paper admitting a certain amount of violet light. This is placed on the lens after exposure on the sitter, and white light is suffered to pass through it for a few seconds and fall on the plate, which is then developed as usual. The ordinary exposure is said to be reduced about one-half by means of this treatment. On the relative advantages of purple light and diffused light for supplementary exposure we can affirm nothing. We know that capable and trustworthy men who have devoted considerable time and attention to comparative experiments in this direction have declared in favor of colored light. The late Mons. Constant, who devoted his attention to the matter, believed in the specific advantage of rosy light, as accelerating most with least risk of veiling or fog. That supplementary light may be made available as an accelerator with little or no risk we are satisfied, both from personal experience and from observation; and that it has hitherto received so little attention and practical application is to us a constant matter of surprise. If S. Scotellari's use of violet light be found an improved mode of using supplementary light, and, if the introduction of it to photographers by Messrs. Marion & Co. induces many to examine the matter who have not hitherto given it attention, we think a special advantage to photographers will be secured.—*Photographic News.*

ELECTRICAL MOVEMENTS OF CAMPHOR ON WATER.*

By P. CASAMAJOR.

YOU are doubtless familiar with the singular motions of camphor when placed on the surface of water, which are of such extraordinary nature as to attract the attention of even the most careless observer. Very eminent philosophers have studied these wonderful gyrations, but little has resulted from their labors to explain the cause of this phenomenon. Among those who have worked on the subject we find the great Volta; we also find Venturi, Brugnatelli, Fourcroy, Biot, Matteucci, and Dutrochet. Mr. Charles Tomlinson, who has given great attention to the subject, published in 1863 a work, in which he gave a full account of previous labors of eminent physicists and chemists on these motions of camphor, to which he added many interesting experiments of his own. I cannot do better than advise those who wish to study the history of the subject to consult this excellent book.

I find in this work that in 1748 Romieu communicated to the Royal Society of Montpellier his observations on camphor, in which he advanced the idea that electricity is the cause of these singular motions. Romieu states that camphor does not rotate on the surface of water placed in vessels of iron or copper, but the experiment succeeds very well in those made of glass, sulphur, or resin. He also states that while camphor is spinning in these vessels it is arrested if the surface is touched with the finger, with iron or brass wire, or a rod of wood; but glass, sealing-wax, or sulphur cannot arrest these motions.

This idea that the motions of camphor on water are due to electricity has met with the disapprobation of all subsequent observers, among whom may be found the names of men who are famous in the history of electricity. Notable among these is Alessandro Volta, who made several experiments to show that electricity had nothing to do with these motions.

Now, I propose to show you this evening that there is an evident connection between electricity and these motions of camphor, and, as Volta and other eminent philosophers are unanimous in asserting that there is no such connection, I may be allowed to say that in the experimental sciences

* Read before the American Chemical Society, October 4, 1877.

there is no authority of as much value as a fact, if the fact has been well observed. I propose, therefore, to show you the facts, and you are to be the observers. These facts naturally lead to the conclusion that the remarkable motions presented by camphor on the surface of water are electrical phenomena. I am not prepared at present to go beyond these facts, and drawing from them what seems an inevitable conclusion. The phenomena which accompany these motions of camphor are very complex, and they have stubbornly resisted every attempt on my part to bring them under a general theory. I am in hope, however, that what I have to present this evening may serve to elucidate this interesting subject.

Camphor is not the only substance which moves spontaneously on the surface of water. Volta discovered the same property in benzoic and succinic acids. Others have added the stearoptenes of essential oils, the butyrates of soda and potassa, carbolic acid, and citric acid;† even pieces of cork soaked in ether will exhibit the same phenomenon for a short time. Naphthalen is mentioned in some books as possessing the same property, but I have found that it has not. These substances, with the exception of the stearoptenes, are heavier than water, and they are with difficulty kept afloat: they are also more soluble than is quite convenient for the experimenter. As they behave exactly in the same manner as camphor towards electricity, I will confine my remarks to camphor, as I have almost entirely confined my experiments to this substance.

If we throw pieces of camphor in water they rise to the surface, and, if the conditions are favorable, they will move on the water as if gifted with life. The larger fragments have slower motions than the smaller, which is due to their greater inertia, for if we sprinkle the surface of the water with lycopodium, after the ingenious idea of Mr. Tomlinson, we will find that the currents that set from the larger pieces are stronger than from the smaller. The mobility of the liquid being greater than that of the larger pieces the liquid moves away from the camphor. The shapes of the fragments of camphor have a great influence on the rapidity of their motions. A spherical piece will exhibit very little motion, while an elongated piece of the same volume, terminated by two pointed pyramids,‡ will rotate with the greatest energy.

Very often the conditions under which the motions take place do not exist, and camphor remains perfectly quiet on the surface of the water. It has generally been supposed that when this happened the surface of the water was covered with a film of dirt—either oil, dust, or something else—which, for some reason, prevented the gyration from taking place. If, however, we keep the same water in a glass for several days, and place in it at different times fragments of the same pieces of camphor, we will sometimes have motions, and at other times not, which points to the conclusion that these irregularities are independent of the camphor, of the cleanliness of the water surface, and of the vessel which holds the water.

In the daytime the motions are more apt to take place than after sundown. Also when the weather is bright, or when it storms, than when the sky is cloudy and the air damp, but without any presages of a storm. In many books we find that these motions of camphor on water are due to evaporation, although some add the truthful remark that this explanation is not satisfactory. When I began these researches I tried several times to determine these motions by heating the water, but without success; while at other times the camphor spun in a lively manner on the surface of ice-water. Evaporation was clearly not the cause.

At this stage of the matter a gentleman, who is one of our associates, communicated to me an observation, which I have already mentioned, that if fragments of the same piece of camphor are placed on several successive days in the same volume of water, sometimes there is motion and sometimes not. It was suggested at the same time that perhaps magnetism or electricity had something to do with it.

Rejecting magnetism as improbable, and not being aware at the time of the disapprobation by eminent philosophers of the existence of any connection between the motions of camphor and electricity, I made the following experiments, which I propose to repeat before you after reading this paper.

Having before me a beaker-glass holding water, on the surface of which small fragments of camphor were dancing with great energy, I rubbed a clean glass rod with flannel, and dipped the rod in the water, when I was surprised to see all the small pieces of camphor suddenly reduced to immobility. This experiment was repeated several times with fresh portions of water and of camphor, and always with the same result. Subsequently, the same glass stirrer, rubbed with tin-foil to render it electrically neutral, failed to produce any effect.

In the next place, the same experiment was tried with a piece of vulcanite previously rubbed with flannel, but the motions of the camphor did not stop, and they even appeared to increase in intensity. To test whether this was the case, I was led to stop the motions with a glass rod, and then touch the water with the excited vulcanite. You may judge of my pleasure when the fragments of camphor began again their gyrations as the vulcanite touched the water. I afterwards ascertained that a rod of shellac or of sulphur had the same effect as one of vulcanite.

The first deduction I made from this was that positive electricity stops these motions of camphor, while negative electricity increases their intensity. The deduction, however, was erroneous, as I subsequently found that if, after the motions are stopped by an excited glass rod, it is taken out, wiped dry, and excited again, and dipped in the water, and if the same operation is repeatedly gone over, the motions recommence and increase in intensity every time the excited glass rod is placed in the water. I also found that motions due to positive electricity may in their turn be stopped by dipping in the water an excited rod of vulcanite.

This requires a word of caution, as by rubbing glass very little positive electricity is obtained, when compared to the negative electricity which may be had, in the same manner and in the same time, from vulcanite, shellac, or sulphur. This difference requires that a negatively electrified rod be used with great nicety, as otherwise we bring in contact with the water more negative fluid than is necessary to neutralize the positive electricity, and, as a consequence, the water becomes at once negatively electrified, and the motions continue without interruption.

When the passage from one kind of electricity to another is very gradual there always occurs an intermediate stage at which, if several pieces of camphor are on the water, they coalesce. Afterwards, when the water becomes more decidedly electric, these pieces part company, sometimes in quite a violent manner. A point of great importance to note is that when the surface of the water is electrically neutral, and pieces of camphor adhere to one another, they remain for a long time without perceptibly diminishing, while when they are in active motion they wear away in a much shorter time.

Gentlemen, I do not feel that I sin against any rule of the strictest logic when I conclude from the facts which I have mentioned that there is a connection between electricity and these motions of camphor. As to the cause of these motions, it resides in the camphor itself, and the explanation of the phenomenon must be found in some property possessed by certain substances, of which camphor is the type, by virtue of which water which has been electrified dissolves them with greater rapidity than when not electrified. If a piece of camphor is held fast on the surface of the water, and lycopodium is sprinkled over this surface, as was done by Mr. Tomlinson, we will see currents flowing outwardly from the camphor. This may be explained by supposing that the water, holding camphor in solution, has the same electricity as the camphor itself. If the fragments are very small and are free, their great mobility allows them in their turn to be repulsed by the surface of the water, which remains comparatively stationary. When we hold fast on the surface of the water a piece of camphor with an irregular outline, we may see, by means of lycopodium, that the currents flowing outwardly from the camphor are very uneven in different directions. The inequality of the currents must, when the camphor is set free, determine its motion in a direction opposite to the resultant of these currents.

The enquiry which now presents itself relates to the nature of the remarkable property which enables some organic substances—such as camphor, benzoic acid, and others which I have mentioned—to move on the surface of water when it is electrified. Dutrochet ascribed these motions to a new force called the *epipolic* force. This amounted to giving up the problem. For my part, although I have endeavored to discover the nature of this property, the results which I have obtained are as yet too meagre and too contradictory for presentation before this Society. I do not despair, however, at some future day to present you with results worthy of your attention.

ELECTRIC ILLUMINATION.

WE herewith publish a report of Professor Tyndall addressed to the Trinity Board, upon the experiments recently carried out to ascertain the relative values of different apparatus for producing intense light.

ROYAL INSTITUTION, November 27, 1876.

SIR: I beg to inform you that on the 21st of this month I had the honor of accompanying to Dover the Deputy-Master and a Committee of the Elder Brethren of the Trinity House, with a view to observing from the sea the comparative action of the magneto-electric machines now mounted at the South Foreland.

The machines experimented on were as follows:

1. Holmes' machines, which have been already established for some years at the South Foreland.
2. Two Gramme's machines.
3. Two Gramme's machines coupled together.
4. Siemens' large machine.
5. Siemens' small machine.

Observations Afloat.—The Corporation's steamer Galatea was employed in these observations, the position first chosen being not far from the Varne Light, and at a distance of 11½ miles from the lighthouses on the Foreland. Observations were subsequently made at various other distances.

In the first place, the new machines sending their currents to the low lighthouse, were compared in succession with Holmes' machine, which produced its light in the high lighthouse. Subsequently the new machines were pitted in pairs against each other—one of the two being in the high and the other in the low lighthouse. Care was taken in each instance to reverse their positions. Thus, whenever Siemens below was compared with Gramme above, the observation was immediately followed by a comparison of Siemens above with Gramme below, and so of the others. All irregularities arising from differences in the apparatus employed above and below were thus eliminated.

Briefly expressed, the following are the results of our observations on the nights of the 21st and 22d of November:

1. The new machines mark a great advance, both in economy and power, as regards the application of the electric light to lighthouse purposes.

Thus, the machine of Holmes, which reflects great credit upon its maker, was found practically equalled by a single machine of Gramme, of considerably less volume, and considerably smaller cost.

This discrepancy as to cost and volume was still greater in the case of the small Siemens machine, which yielded a light sensibly equal to that of Holmes'. I am not sure that this equality exists in all azimuths; for if it was only towards the end of the observations that I learned that directions had been given to place the carbons of Gramme and Siemens "in their best position." The section of this report headed "Observations ashore" will throw more light upon this point. The size and expense of the small Siemens machine are only fractions of those of Gramme, while the size and expense of Gramme are only fractions of those of Holmes. I was verbally informed by Mr. Douglass that the relative cost of the small Siemens and the Holmes is as one to ten, the price of the former being 75*l*., while the price of the latter is 750*l*.

2. The comparative merit of the single Gramme and the small Siemens is indicated in the foregoing paragraphs. They are sensibly equal to each other, both of them producing an exceedingly fine light.

I was particularly impressed by the performance of the small machine of Siemens. Its power, in relation to its size, is surprising.

3. The large machine of Siemens, however, greatly transcends both his small machine and the single machine of Gramme. The Elder Brethren may accept, as closely approximating to the truth, the statement that the large machine of Siemens is sensibly equal to the two Gramme's machines coupled together.

The light from the large Siemens, as also that from the two coupled Grammes, is of extraordinary splendor.

In point of cost, however, the advantage rests with Siemens; for, whereas the price of his large machine is 265*l*., the price of the two Gramme machines, producing the same light, is, as Mr. Douglass informs me, 600*l*.

The Gramme's machines employed in these experiments were constructed in the workshops of Mr. Robert Sabine. The French constructors of these machines have, I believe, found it difficult to send the currents from two of them through the self-same lamp. This difficulty was successfully overcome by Mr. Ross, the agent of Mr. Sabine, at the South Foreland. The augmentation of light by the coupling together of the two Grammes was very great.

If the union of two small Siemens machines would produce an augmentation of the light similar to that obtained from the union of two Grammes, the employment of two such small machines would be extremely handy and economical. With a view to obtaining information on this head, I called upon Mr. Carl Siemens, and learnt from him that, so far as he knew, no experiment had ever been made with the two machines acting together. He promised, however, to clear up this point by writing to his brother in Berlin; and as soon as his answer reaches me, it shall be communicated to the Elder Brethren.

The heating of the coils by the induced currents is a point still to be determined, by subjecting the machines to long continued action. So far as I can judge from the experiments at the South Foreland, the heat developed in Gramme's machine is certain to be of no account, while in the machines of Siemens it is unlikely to be injurious.

In recording the observations made on the 21st and 22d, numerical values, as the Committee are aware, were assigned to the different lights. I have not thought it necessary to introduce such numbers here. They constitute a concise and convenient mode of recording equalities and differences; but regarded quantitatively, they would, in my opinion, be but poor approximations to the truth. The time for numbers will arrive when the contemplated photometric comparison of the lights has been executed.

Siemens' and Gramme's inventions undoubtedly place at the disposal of the Elder Brethren electric lights of surpassing energy. Combining either the large machine of Siemens, the two Gramme's machines, or if practicable, the two small machines of Siemens, with one of the group-flashing dioptric apparatuses which have been recently devised by Dr. Hopkinson, a light transcending in power and individuality all other lights now existing would probably be obtained. Such a light would displace with enormous advantage to the mariner the two lights hitherto displayed at the Lizard. A fixed light, even should it be the electric

TABLE SHOWING THE COST, DIMENSIONS, WEIGHT, HORSE POWER ABSORBED, AND LIGHT PRODUCED BY THE DYNAMO-ELECTRIC MACHINES, TRIED AT THE SOUTH FORELAND, 1876-77.

Names of Machines.	Dimensions. Length.	Dimensions. Breadth.	Dimensions. Height.	Weights.	Horse Power absorbed.	Revolutions per Minute.	Light produced in Standard Candles. Condensed Beam.	Light produced in Standard Candles. Diffused Beam.	Light produced per Horse-Power in Standard Candles. Condensed Beam.	Light produced per Horse-Power in Standard Candles. Diffused Beam.	Size of Carbons.	Order of Merit.
	ft. in.	ft. in.	ft. in.	tons. cwt. qrs. lb.							in. in.	
Holmes	4 11	4 4	5 2	2 11 1 7	3.2	400	1,523	1523	476	476	[illegible] by [illegible]	VI.
Alliance	4 4	4 6	4 10	1 16 1 21	3.6	400	1,953	1953	543	543	[illegible] " [illegible]	V.
Gramme (No. 1)	2 7	2 7	4 1	1 5 2 0	5.3	420	6,663	4016	1257	758	[illegible] " [illegible]	IV.
Gramme (No. 2)	2 7	2 7	4 1	1 5 2 0	5.74	420	6,663	4016	1257	758	[illegible] " [illegible]	IV.
Siemens (Large)	3 9	2 5	1 2	0 11 2 18	9.8	480	14,818	8932	1512	911	[illegible] " [illegible]	III.
Siemens (Small, No. 58)	2 2	2 5	0 10	0 3 3 0	3.5	850	5,539	3339	1582	954	[illegible] " [illegible]	II.
Siemens (Small, No. 68)	2 2	2 5	0 10	0 3 3 0	3.3	850	6,864	4138	2080	1254	[illegible] " [illegible]	I.
2 Holmes	9 10	4 4	5 2	5 2 2 14	6.5	400	2,811	2811	432	432	[illegible] " [illegible]	—
2 Gramme	5 2	2 7	4 1	2 11 0 0	10.5	420	11,396	6869	1085	654	[illegible] " [illegible]	—
2 Siemens (Small, Nos. 58 and 68)	4 4	2 5	0 10	0 7 2 0	6.6	850	14,134	8520	2141	1291	[illegible] " [illegible]	—

† Hence, as suggested by Tomlinson, a quick way of distinguishing citric acid from tartaric acid, which does not possess this property.

‡ As camphor breaks up very readily while being cut, I have agglomerated it into cylinders by compressing it in a Plattner's ore crusher. Thus compressed it stands handling much better.

light, at a distance is not to be distinguished from a ship light or an ordinary shore light near at hand. A few evenings ago, for example, I was unable to distinguish one of the Foreland lights from the light of a lantern on the beach at Dungeness. Distinctiveness is sure to be more and more insisted on, as an essential feature of the lights of the future. It would not therefore, in my opinion, be a wise application of the extraordinary means of illumination now at our disposal to copy the old arrangement at the Lizard, by placing there two fixed electric lights, instead of the more powerful, more distinctive, and less expensive group-flashing light to which I have above referred.*

Observations Ashore.—On the 22d of November, we visited the South Foreland, inspected the arrangement of the machines, and observed their light-producing power close at hand. Here the only points I have to submit to the Elder Brethren are the following:

In both Siemens' and Gramme's machines the induced currents are sent in a constant direction. One of the carbons is always positive, the other always negative—not alternately negative and positive as in the machine of Holmes. The positive carbon is heated more intensely, and it wastes more rapidly than the negative one; its shape, moreover, is a point of some practical importance. From the positive to the negative carbon there is a transfer of particles which usually produces a crater-like hollow in the positive carbon. The concave surface of this crater is the place of most vivid incandescence, and it is easy to see that the radiation from that surface, when the positive carbon is the higher one, as it is in the arrangement at the South Foreland, would be directed to the earth. To obviate this inconvenience, the negative carbon is usually somewhat displaced, so as to cause the most vivid incandescence to occur on one side of the positive carbon. The portion of space towards which this side is turned receives from it a greatly augmented radiation. But the radiant power thus concentrated on one side is withdrawn from the other, which would be inadmissible if a whole circle had to be uniformly illuminated. In most cases, however, only a portion of the entire circle is required; and no disadvantages arise from the weakening of the landward radiation.

If no valid mechanical grounds oppose the alteration, it would, I think, be a decided advantage to make the lower carbon the positive one. Its upward radiation would be utilized by the upper prisms to a far greater extent than its downward radiation is now utilised by the lower ones.

It is proposed that a month's trial be given to the machines at the South Foreland. I would add that the trial would be rendered complete by observing the light in all attainable azimuths, both when the carbons are in the same vertical plane, and when the negative carbon is displaced so as to give a preponderant outflow of light in a special direction.

* * * * * * * * * * * *

I have the honor to be, &c.

Mr. Robin Allen. JOHN TYNDALL.

REFLECTION OF HEAT.

THE reflection of heat by metals has recently been studied by a German observer, M. Knoblauch, in the case of brass, nickel, zinc, German silver, copper, gold, silver and brass (*Pogg. Ann.*). Solar heat was used, being sent in a fixed direction by a heliostat and polarized by a Nicol, either parallel or perpendicular to the plane of refraction, or at 45° with it. The intensity of the reflected heat varies with the incidence; it increases with this when the heat is polarized parallel or at 45° to the plane of reflection (though the increase is less sensible in the latter case). When heat is polarized perpendicularly to the plane of incidence, the intensity decreases at first with the incidence up to the angle of polarization, and thereafter increases. With the same angle of incidence the intensity of the reflected heat is always less with the polarization at 45°, and still less with the perpendicular polarization than with that parallel to the plane of reflection. The different metals show very different behavior. The differences in intensity, very well marked in steel or nickel, are almost *nil* in brass. This latter communicates by reflection circular polarization to natural heat. The other metals produce, it is known, elliptic polarization; and glass, which produces rectilinear polarization, may be regarded as the extreme opposite case to brass.

UNITED STATES MINING LAWS.

QUARTZ MINES.

THE United States mining laws provide that after May 10th, 1872 (the date of the passage of this law), any person who is a citizen of the United States or who has declared his intention to become a citizen, may locate and hold a mining claim of 1,500 linear feet along the course of any mineral vein or lode subject to location; or any association of persons, severally qualified as above, may make joint location of such claim of 1,500 feet; but in no event can a location of a vein or lode, made subsequent to the date mentioned, exceed 1,500 feet along the course thereof, whatever may be the number of persons in the company.

With regard to the extent of surface ground adjoining a lode or vein, and claimed for the convenient working of the same, the Revised Statutes provide that the lateral extent of location, made after May 10th, 1872, shall, in no case, exceed 300 feet on each side of the middle of the vein at the surface, and that no such surface rights shall be limited by any mining regulations, to less than 25 feet on each side of middle of the vein at the surface, except where adverse rights, existing on the 10th of May, 1872, may render such limitations necessary; the end lines of such claims to be in all cases parallel with each other.

By the foregoing it will be seen that no lode claim, located after May 10th, 1872, can exceed a parallelogram 1,500 feet in length by 600 in width, but whether surface ground of that width can be taken depends upon the local regulations, or State or Territorial laws in force in the mining districts; and that no such local regulations, or State or Territorial laws, shall limit a vein or lode claim to less than 1,500 feet along its course, nor can surface rights be limited to less than 50 feet in width, unless adverse claims, existing on May 10th, 1872, render such lateral limitations necessary. It is provided by the Revised Statutes that the miners of each district may make rules and regulations not to conflict with the laws of the United States, or of the State or Territory in which the districts are situated, governing the location, manner of recording, and amount of work necessary to hold possession of a claim.

In order to hold a possessory right to a location, made prior to May 10th, 1872, not less than $100 worth of labor must be performed or improvements made thereon, within one year from the date of such location, and annually thereafter; in default of which the claim will be subject to relocation by any one else having the necessary qualifications, unless the original locator, his heirs, assigns, or legal representatives, have resumed work after such failure and before the relocation. The expenditures required upon mining claims may be made from the surface or in running a tunnel for the development of such claims. The act of February 11th, 1875 providing that where a person or company has run a tunnel for the purpose of developing a lode or lodes, the money so expended shall be considered as expended on the said lode, and the owner or owners shall not be required to perform work on the surface to hold the claim.

PLACER CLAIMS.

The laws provide that no location of a placer claim, made after July 9th, 1870, shall exceed 160 acres for any one person or association of persons, which location shall conform to the United States surveys. All placer claims, located after May 10th, 1872, shall conform as nearly as practicable with the United States system of public surveys, and no such location shall include more than 20 acres for each individual claimant.

These provisions of the law are construed by the Commissioner of the General Land Office, to mean that after the 9th of July, 1870, no location of placer claim can be made to exceed 160 acres, whatever may be the number of locators associated together, or whatever the local regulations of the district may allow; and that from and after May 10th, 1872, no location made by an individual can exceed 20 acres, and no location made by an association of individuals, can exceed 160 acres, which location cannot be made by a less number than eight *bona fide* locators; but whether *as much* as 20 acres can be located by an individual, or 160 acres by an association, depends entirely upon the mining regulations in force in the respective districts at the date of the location; it being held that such mining regulations are in no way enlarged by the statutes, but remain intact and in full force with regard to the *size* of locations, in so far as they do not permit locations in excess of the limits fixed by Congress, but that when such regulations permit locations in excess of the maximum fixed by Congress, they are restricted accordingly. A local regulation is valid, therefore, which provides that a placer claim, for instance, shall not exceed 100 feet square. Congress requires no annual expenditures on placer claims, leaving them subject to the local laws, rules, regulations and customs.

NEW DISCOVERIES IN THE PENNSYLVANIA OIL REGION.

C. HENRY RODNEY, C.E., in a letter to the Philadelphia *Press* from Corry, Pa., says:

"Wells are now being sunk in search of oil in Elk, Clinton, Cameron, Tioga, Bradford, and Westmoreland Counties. The 'Bradford region,' near the town of that name, in the northern part of McKeon County, is more extensive than at first supposed. The wells are about 700 to 900 ft. in depth, and yield about 100 barrels each per day when first sunk, their aggregate production now being more than one tenth that of the entire State.

"In Elk County one is down 600 ft. without as yet giving any show of oil, but about 5 miles north of Wilcox, another one, down 2,000 ft., with a set of boring tools lost in it, is an intermittent flowing well. It is quiescent for 8 minutes, then suddenly spouts salt water and gas, with a small quantity of oil, to a height of 150 ft. for 2 minutes. At night the gas is lighted for the amusement of visitors, and is a magnificent sight, the water assuming all the colors of the rainbow, and the gas burning with an intense glare and with a noise which can be heard for miles.

"At Mansfield, in Tioga County, a well is down 1,200 ft., and another, at Elkland, in the same county, 700 ft., but without as yet a satisfactory show.

"In Cameron County preparations are being made to start three of these wells at Emporium, one at Portage, and another on the Sinnemahoning. One near Emporium has already reached a depth of 600 ft.

"Six miles east of Renovo, on Hyner's Run, in Clinton County, about three weeks since, a well was commenced, and is now down 880 ft. in red sandstone rock. Salt water was struck at a depth of 185 ft. At 420 ft. a vein of gas was struck, which, on being ignited, blazed up to a height of 20 or 30 ft., threatening the destruction of the derrick, but with some difficulty the flame was extinguished and drilling resumed. By rail Hyner's Run is 41 miles east of Williamsport and 21 miles west of Lock Haven, so in case it yields no oil, if the volume of gas is sufficient, it might be conducted to those points.

"One of the latest oil discoveries is at the mouth of Chartiers Creek, Westmoreland County, on the Allegheny Valley Railroad, 22 miles north of Pittsburg. Another well on Beaver Run, in the same county, is down 300 ft., with a good show in the second sand rock; they expect to strike oil at less than 1,000 ft. from the surface. Another well has just struck at Edenburg, Clarion County, *between* the supposed eastern and western belts, and is yielding 600 barrels per day. This well is near the Helen furnace, 8 miles northeast of the town of Clarion, and some 10 miles distant from the large producing section of that country. It is situated exactly on the 45th degree line from Edenburg, and has long been looked upon as possible oil territory, though no previous attempts at development have been made. Another well is being sunk on exactly the same line some 10 miles beyond this—or 22 miles from the Edenburg district.

"Oil has since been struck in the well on Hyner's Run at a depth of 1,015 ft. There is much excitement in Lock Haven, where the new well is owned, and preparations are being made to put several more wells down in the same vicinity at once. This is the most easterly point on the Sinnemahoning at which oil is found."

THE SYSTEM EMPLOYED IN DRILLING FOR OIL.

C. HENRY RODNEY, C.E., observes: "The system of drilling now in vogue is a great improvement on that pursued a dozen years ago in the use of 'casing' to shut off the surface water. The surface wells, 300 or 400 ft. deep, put down from 1861 to 1864, were drilled about 2½ in. diameter, with a set of tools weighing about 300 pounds, attached to a 'spring pole' with a derrick about 25 or 30 ft. high, operated by two men, the spring pole being something like the pole of an old-fashioned well, and 15 or 20 ft. a day was considered rapid progress. As the weight of the tools, the diameter and depth of the well was increased, horse-power, and afterwards steam-power, was substituted for the 'spring-pole.' With the present system a derrick of 65 to 75 ft. height is first put up; steel-edged cast-iron driving pipe 8 in. internal diameter is then driven through the surface soil until it rests on solid rock; then a hole 8 in. diameter is drilled with tools weighing about 2,000 pounds to a depth below the surface varying from 150 to 500 or more ft., when a 'casing' of light iron pipe, 6 in. internal diameter, is lowered down and rested in the rock, and the holes continued down 5¼ in. diameter, until oil is struck or a depth usually sufficient to reach it in that region has been attained. When the well is tubed and pumped for a reasonable length of time, if no oil is yielded, some torpedoes are exploded in it in order to open up communication with crevices containing oil, if possible, and if no oil is then obtained it is abandoned. Sometimes the elastic force of the confined gas is so great that, upon striking the crevice containing it, it forces the tools out, and the oil commences to flow without pumping; at other times pumping may be required for a few days or continuously. With the heavy tools now in use 70 ft. per day is sometimes averaged. In the old method of boring without casing the hole was kept full of water, which followed the drill down, exerting a pressure of over 300 pounds per square inch at a depth of 700 ft., which the gas must overcome before the oil would flow spontaneously, and in many cases is supposed to have driven the oil into other channels before the pump was put in, sometimes even flooding another well at some distance which had been yielding oil. By using 'casing' these risks are prevented, as the surface water is prevented from reaching deeper portions of the well. As the tubing and casing are withdrawn from abandoned wells, they should be required to be plugged below the surface water-veins, otherwise the producing wells of the district will sooner or later be ruined by being flooded with surface water or the escape of gas."

THE FLOW OF NATURAL GAS.

C. HENRY RODNEY, C.E., says: "The increasing use of the gas which escapes in enormous quantities from many of the wells sunk for oil, is attracting much attention for lighting and heating manufacturing purposes. At some of the wells it has been used for years in place of coal for getting up steam, being conducted into the fire-box of the boiler and ignited. At others, where the pressure is sufficient, it is sent into the cylinder of the engine in place of steam, the pressure sometimes being as high as 1,000 pounds per square inch. Some of the wells yield an enormous quantity of gas of high illuminating quality for years, sometimes being sufficient for lighting and heating purposes for whole towns, while at others the gas is allowed to escape, and being ignited, gives a brilliant flame, which illuminates the country for miles. At Sheffield, Warren County, Pa., there is a well a few feet south of the railroad track, 900 ft. deep, bored two and a half years ago, and which yields two to three millions cubic feet of gas every 24 hours, a portion of which is used for illuminating and heating the town, the rest being allowed to burn at the well. The gas from some of the wells 1,000 ft. deep, and 30 miles above Pittsburg, is conducted to furnaces near that city, and used in puddling iron at very much less cost than coal. It has one great advantage, its entire freedom from sulphur and phosphorus, being nothing but hydrogen and carbon. There are now about 15 gas wells in the city of Erie, Pennsylvania, for manufacturing, lighting, heating, and cooking purposes. Their depth is about 700 or 800 ft., and the cost of drilling and tubing them about $1.50 per foot. The gas from these which I examined, apparently, has higher illuminating power than ordinary coal gas, and gives the best results with an argand burner and chimney. It seems perfectly practicable to extend pipe lines to our large contiguous cities for the purpose of conveying and utilizing this gas in place of allowing it to escape as it does at present, and I have no doubt it will ultimately be done."

DIAMOND-BEARING SAND.

By S. MEUNIER.

THE author, having obtained several well authenticated specimens of the diamond-bearing sand from Southern Africa, has succeeded in isolating several substances which have not been previously mentioned as occurring therein, and has been led to form an opinion concerning its origin different from that which is generally held.

From the sand were separated about 80 varieties of grains, which may be readily divided into (i) particles of rock, (ii) minerals properly so called. Among the rock grains were noticed serpentine, a rock formed of garnet and smaragdite, another of smaragdite and ilmenite; an altered eclogite, dibasite, pegmatite and talc-schist.

Among the minerals in isolated grains were diamond, topaz, garnet, smaragdite, bronzite, ilmenite, quartz, tremolite, asbestos, wollastonite, voalite, many zeolites, calcite, opal, red jasper, agate, iron pyrites, limonite, etc.

Geologists have unanimously agreed to assign to diamond-producing sands a deep-seated origin, an opinion which is supported by their disposition in vertical masses or layers; it has also been supposed that they owe their present position to the alteration *in situ* of pyrogenic rocks originally emitted in the form of lavas. The latter hypothesis seems to the author to be untenable in face of the list of substances given above as constituents of this variety of sand. Putting aside the more purely mineral specimens, it would seem to be impossible that so large a number of complex rocks, possessing such varying characters, could be formed under identical conditions, or produced at one and the same time in a state of mixture by the action of the same causes. He thinks it much more reasonable to suppose that each individual rock fragment has been torn from some special lay or deposit, and has afterwards been transported to the spot where the mixture actually took place.

By admitting on the one hand the deep-seated origin of diamond-bearing sand, and, on the other hand, by recognizing in it the product of mechanical removal or transport, this deposit is brought into the same category as the vertically disposed granitic sands to which, under the name of "vertically alluvial deposits," the author has already directed the attention of geologists.—*Compt. Ren.*

Mr. R. Hanks, coal-miner near Galesburg, Illinois, is reported to have dug out of the earth, "fifty feet below the surface," the entire carcase of a petrified mastodon sixteen feet long and nine high, in almost perfect shape. We need scarcely say that the news requires confirmation, especially as a second petrified human giant has been discovered in another part of the States.

* The character of the light to be exhibited when the electric system should be introduced at the Lizard had been discussed and determined in 1874-5, and the lanterns, optical apparatus and other costly items of the new outfit were already completed when the report was received. The Board, however, brought the question again under review, in connection with the above observations, and in the result confirmed their resolution to retain the distinctive character now belonging to the lights at Lizard.

POINTS OF A GOOD HORSE.

THE committee appointed by the New England Agricultural Society to decide upon rules for guidance of judges upon horses has reported in full as follows, and the document will be given to the Society next February:

1. The several committees are directed to make no awards of premiums unless the animal is of superior quality and merit.

2. Committees are instructed in no case to award a premium to an unsound animal (excepting horses entered for trotting purses).

3. Exhibitors shall give the pedigree and record of each animal, when known, and shall be bound by rule 4.

4. Any exhibitor giving a false pedigree or record shall forfeit any and all moneys or premiums awarded to him at the fair.

5. All horses shall be judged by the accompanying scale of (100) points, modified by the following rules:

6. Stallions and draft horses shall be judged by the scale of points, excepting that the standard for speed and size shall be fixed by the judges.

7. The judges may add fifty points, or a less number, to any stallion for excellence of his produce.

11. Each animal shall be entered in his class. The judges shall put every animal into the class in which he belongs, if it is wrongly placed.

12. The judges shall have ten days from the date of exhibition to correct their awards from any facts subsequently ascertained; but they shall not change their award for any fact known to them at the time the award was made.

Points of excellence—size - While mere bulk is comparatively useless, a fair amount of substance is absolutely necessary. The tall horse is apt to be leggy and long in the cannon-bones. Length in the arm, shoulders, thighs, and haunches is desirable. Highest figure 10

Color.—(It is an old adage that a good horse is any color, but there are exceptions to all rules.) Bay, chestnut, black, and brown are good colors, although the bay and black, especially for matched horses, are probably most sought after and admired 10

Symmetry of body.—The withers should be high and thin; shoulders, oblique and muscular, showing good leverage; chest, large, wide above, and deep; back, short and broad; barrel, round and close-ribbed; loins, strong and muscular; body, strong underneath; rump, moderately drooping and well-muscled 10

Head and neck.—The head should be clean and delicate, and as small as would be in keeping with the rest of the body; wide and flat between the eyes; forehead, bold and prominent; muzzle, fine; nostrils, large; mouth, deep; lips, thin and firmly compressed; throttle, broad and deep; neck, good length, thin on top, with windpipe well detached 5

Eye and ear.—The eye should be large and prominent. The eye of the horse is an accurate index of his temper, and experience has shown if too much white is visible he is a dangerous one. The ear should be thin, erect, and not too long—quick and lively. The ear indicates both spirit and breeding. 5

Feet and limbs.—The feet should be smooth, fine texture, and well shaped, with good ground surface; heels, not too high; frog, large and elastic. The arm should be long and large; knee, long and flat; sinews, prominent and firm; pasterns, strong and properly inclined; stifle, strong and powerful quarters, deep, reaching down into long but smooth hocks; hock, large, long, clean, and well proportioned. The leg, from hock down, should be straight, short, and flat, with sinews standing well out from the hip bone and free from all defects. The hind pasterns should be stronger and more oblique than the pasterns of the fore leg 15

The tail.—The tail should be long and full, muscular, and well set upon the rump, carried free. The bone should not be too large or coarse 5

Speed at the trot.—The gate should be an even, regular, honest, and genuine trot, without requiring boots or weights. The ability to pull weights is a quality of exceeding value, and, when found in combination with speed and stoutness, we may say that the prime characteristics of the harness horse are obtained 15

Speed in walking.—The step should be bold, firm, and elastic 5

Style and action.—The high action and elegant carriage so desirable in the park horse is not considered so necessary in the gentlemen's driving and family classes. Still, there should be easy and graceful action, combined with well-balanced harmony of parts, together with speed, intelligence, and fearlessness, which are indispensable in this class of horses. The action should be free and clear, dispensing with the necessity of boots or other safeguards on the limbs of the animal 10

Docility 10

Total 100

STANDARD SIZE AND SPEED.

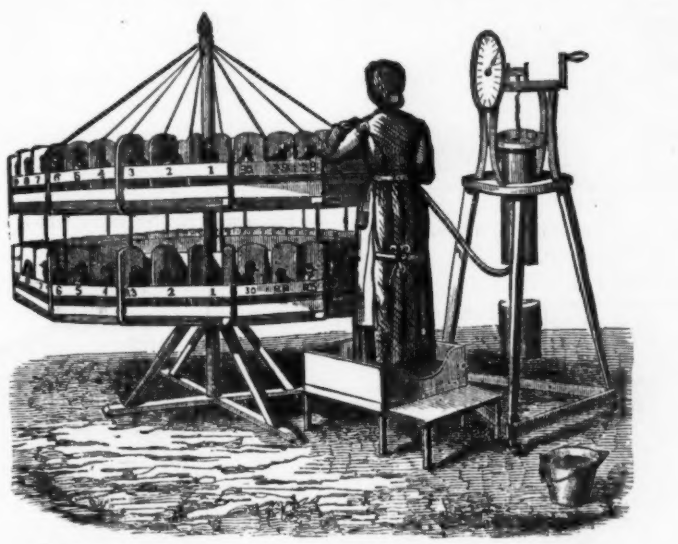
					min.
Matched carriage horses,	height,	16 hands;	speed,	6	
" gent's driving	"	" 15½	"	"	3:30 "
Family	"	" 15½	"	"	5:30 "
Gent's driving	"	" 15½	"	"	3:15 "
Park or phaeton	"	" 16	"	"	4 "

FATTENING POULTRY BY MACHINERY.

THE practice of artificially "cramming" birds by various methods, to hasten the process of fattening and to improve the quality of the flesh for the table, dates from the earliest antiquity. Until within a few years no improvement upon ancient methods seems to have been devised. More than 2000 years ago Cato described his system of "cramming." Two centuries later Varro gave his experience; while Columella and Paladius have written voluminously on the same point. To deprive the birds of light and of the power of motion, and to cram them to repletion with pellets of farinaceous food, seems the common basis of both systems, ancient as well as modern.

The ingenious contrivance, to which we now call attention, is the invention or conception of a French poultry breeder. The apparatus consists of a table; instead of perches, the cells in the rotary frame are flat-bottomed, the posterior half of their floors being open, with the exception of a wire, to allow the excrements to drop through to the ground. This hollow construction renders it easily ventilated and kept clean. Steel chains are employed as tethers, fastened round each foot of the birds with clasps or buckles, each foot being fastened to its own side of the cell, yet admitting of slight motion.

The feeding machine is extremely simple, and is made to expel its contents through a flexible tube, made of rubber, in response to a gentle pressure of the operator's foot upon a pedal attached to it; at the same time the amount passing through the tube is indicated on a dial in front of the operator. The operator seizes with the left hand the neck of the chicken, and, pressing on each side of the beak, the bird is forced to open its mouth, while with his right hand the feeder carefully introduces the nozzle of the flexible tube communicating with the reservoir of food, and conveys into the stomach the desired amount of food. Since the cabinet may be turned on its axis, the feeder has no occasion to change his place. A skillful operator can cram 400 chickens in an hour.



POULTRY FATTENING BY MACHINERY.

Under this régime it requires an average of fifteen days to fatten a duck, eighteen for a chicken, twenty for a goose, and twenty-five for a turkey. The pullets are fed three times a day and the ducks four times. The food used for chickens is barley and corn meal, mixed with milk into a dough so thin that no other liquid is necessary; the ordinary quantity given is from seven-tenths to one and four-tenths of a gill each time. The pullets are not allowed to drink, but ducks are given water at stated intervals. Only birds between three and six months old are treated.

Many advantages are claimed for this system over the practice that prevails in Europe of fattening by hand, where the birds are placed in dark and narrow places, completely deprived of fresh air, and kept in the midst of their own excrement, since under such conditions the process of fattening is a veritable torture, while under this improved system the birds are always in fresh air, and are not kept in dark ness. The cabinets are cleaned each day with scrupulous care, everything about them is washed and disinfected. No suffering is caused by the feeding, which is effected in an instant, and the birds are always in a superior condition, while the care of them is an amusement rather than an irksome task to the attendants in charge.

Not only is the time employed in feeding greatly reduced but the daily ration is easily regulated, and may be given with desirable regularity; and, above all, it is claimed that great excellence is secured in the special quality of the meat. It is solid, very tender, exceedingly fine grained, not over fat, very white in color and of a flavor of remarkable excellence.

WHAT EARTHWORMS ARE GOOD FOR.

FROM observations extending over a number of years, M. Hensen is led to the conclusion that infertile undersoil is rendered valuable by the action of worms in two ways, viz., by the opening of passages for the roots into the deeper parts, and by the lining of these passages with humus. This will be more fully understood from the following facts regarding the life-habits of the worm (*Lumbricus terrestris*) given in M. Hensen's paper in the *Zeitschrift fur wissenschaftliche Zoologie*.

It is known that the adult animals in wet weather come up to the surface by night, and, with their hinder end in their tube, search the ground round about. They then draw whatever vegetable material they can find into their tubes—fallen stems and leaves and small branches. In the morning one then finds little heaps of plant fragments projecting at various parts of the surface, and each of them penetrating the tube of a worm. On closer examination it is found that the leaves have each been rolled together by the worm, and then drawn into the tube in such a way that the leaf-stalk projects. The portion of the leaf in the tube is moist and softened, and only in this state are plants consumed by the worm. These are distinct indications that the worm gnaws them, and after some days the meal is ended. The food is never drawn deeper down into the ground. In digging the ground at various seasons it was only very rarely that plant remains were found in the subsoil, and probably they got there by accident.

With reference to the structure of the worm-tubes, some interesting facts were established in these researches. In humus their character is difficult to make out, owing to the looseness of the mass. In sand they proceed almost vertically downwards three, four, or even six feet, whereupon they often extend some distance horizontally; more frequently, however, they terminate without bending. At the end of the tube the worm is found with his head upwards, while round about him the tube is lined with small stones. On the sandy wall of the tube one observes more or less numerous black protuberances which make the sand fertile. These are the secretions of the worm, which, after being removed out of a tenanted tube, are found next morning replaced by fresh matter. They are observed after a few days, when a worm is put in a vessel with clean sand, and allowed to make a tube for itself. Older abandoned tubes are pretty regularly lined with the earth formed by the worm, and some passages are densely filled with black earth. This black substance appears to diffuse somewhat into the sand.

In about half of the tubes, not quite newly made, M. Hensen found roots of the plants growing at the surface, in the most vigorous development, running to the end of the tube and giving off fine root-hairs to the walls, especially beautiful in the case of leafy vegetables and corn. Indeed such tubes must be very favorable to the growth of the roots. Once a root-fibre has reached such a tube it can, following the direction of gravity, grow on in the moist air of the passages, without meeting with the least resistance, and it finds moist, loose, fertile earth in abundance.

The question whether all roots found in the under-soil have originally grown in the tubes of worms, cannot be answered with certainty. It is certain that the roots of some plants penetrate themselves in the sand, but not to great depths. M. Hensen is of opinion that the tap-roots, and in general such root-forms as grow with a thick point, can force a path for themselves, while the fine and flexible suction-roots have difficulty in obtaining a path into the depths other than what has been previously made for them. Roots of one year's growth especially can penetrate deep into the subsoil, only where there are earthworms.

A microscopical comparison of the earth deposited by the worm shows that it is like the two-year leaf-mould prepared by gardeners for the filling of flower-pots. Most of the plant-cells are destroyed; still there are present some cells and shreds of tissue, browned and friable, mixed with many sand grains and brown organic fragments. The chemical composition of the worm-earth shows much similarity to that of fertile humus ground. Its fertility, therefore, cannot be doubted, though direct experiments with it are wanting.

With regard to the numerical value of this section of the earthworm, the following observations by M. Hensen afford some information:

Two worms were put into a glass pot 1½ feet in diameter, which was filled with sand to the height of 1½ feet, and the surface covered with a layer of fallen leaves. The worms were quickly at work, and after 1½ months many leaves were down 3 inches deep into the tubes; the surface was completely covered with humus 1 cm. in height, and in the sand were numerous worm-tubes partly fresh, partly with a humus wall 3 mm. thick, partly quite filled with humus.

Counting, when an open opportunity offered, the open worm-tubes in his garden, M. Hensen found at least nine in the square foot. In 0·15 square metres two or three worms were found in the deeper parts weighing three grammes: thus in the hectare there would be 133,000 worms with 400 kilos. weight. The weight of the secretions of a worm in twenty-four hours was 0·5 grammes. While these numbers are valid only for the locality referred to, they give an idea of the action of this worm in all places where it occurs.

The assertion that the earthworms gnaw roots is not proved by any fact; roots gnawed by worms were never met with, and the contents of the intestines of the worms never included fresh pieces of plants. The experience of gardeners that the earthworm injures pot plants may be based on the uncovering or mechanical tearing of the roots.

"Let us take a retrospective glance," concludes the author, "over the action of the worm in relation to the fertility of the ground. It is clear that no new manure material can be produced by it, but utilizes that which is present in various ways. 1. It tends to effect a regular distribution of the natural manure material of fields, inasmuch as it removes leaves and loose plants from the force of the wind and fixes them. 2. It accelerates the transformation of this material. 3. It distributes it through the ground. 4. It opens up the undersoil for the plant roots. 5. It makes this fertile."

AMONG the latest plants naturalized in California is that of coffee. Since its introduction, four years ago, it has become very productive, yielding a bean of strong aromatic flavor, and growing as vigorously as in the coffee countries of South America. There are extensive plantations in Central and Southern California, which pay handsome profits.—*Ex.*

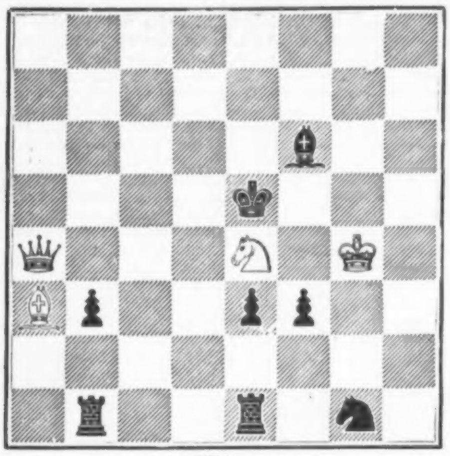
THE *Journal d'Agriculture Pratique* states that the worms which do so much damage to potted plants can always be got rid of by using for the plants water to which a tenth part of grated horse-chestnut has been added. Under this treatment the worms must either flee or die.

SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department, may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 37.—By CONRAD BAYER, of Olmutz, Austria. First Prize in Paris Tournoi of 1857.

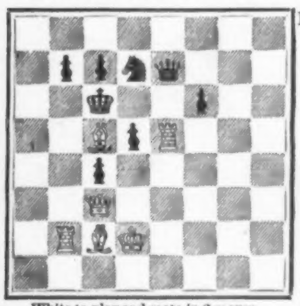
Black.



White.

White to play and mate in four moves.

KOLISCH AND THE PARIS TOURNOI OF '57.



White to play and mate in 2 moves.
By E. B. COOK.

PERHAPS no more appropriate time than the present, while the attention of the chess world is being directed towards the forthcoming exhibition, could be chosen for giving a brief account of the last grand Tournoi of Paris. We present a portrait of Mr. Kolisch, hero of that memorable contest, who, according to our estimation, was the strongest player of that date, and, contrary to the popular impression, is one of the most brilliant and rapid players known.

A false idea prevails that Mr. Kolisch is a slow player based, we think, on the record of one or two of his matches in which an immense amount of time was consumed, and innumerable draws effected, as in the case of his remarkable encounter with Paulsen, when the match was abandoned after seventeen drawn games had been played.

We have played many games with Kolisch, and have seen him play with scores of others, and can safely assert that he is a most rapid player, who, in his most serious games, never consumes as much time as his opponents

Mr. Kolisch has composed but few problems, although he takes great interest in them and is the best solver we have ever met. Besides being famous as a chess player, Mr. Kolisch is one of the first mathematicians of Europe, and is an accomplished linguist, speaking all of the modern languages with perfect fluency. For several years he has been residing in Vienna, where he has been a liberal patron to chess, although he seems to have entirely withdrawn from play. It is to be hoped now that he has returned to Paris that he will take an active part in the forthcoming chess congress.

The Paris Tournament of 1867 commenced on June 4, at the Exhibition building, the chief prize being for a beautiful vase presented by the Emperor, and 500 francs added by the managers. The following thirteen players participated:

J. Kolisch, Presburg, Hungary, First Prize: 5,000f.
S. Winawer, Warsaw, Poland, Second Prize: 800f.
W. Steinitz, Prague, Austria, Third Prize: 400f.
G. Neumann, Gleiwitz, Prussia, Fourth Prize: 200f.
C. DeVere, Stirling, England.
J. A. DeReviere, Nantes, France.
C. Golmayo, Logrono, Spain.
J. Czatnouski, Warsaw, Poland.
S. Loyd, America.
S. Rosenthal, Suwalki, Poland.
S. From, Copenhagen, Denmark.
E. Rouseau, St. Denis, France,
Baron D'André, Paris.

A handicap tournament, as well as several matches, were afterwards played at the Café de la Regence, but, although they are referred to in the Book of the Tournament, they created no interest whatever, and we are surprised to learn that they are claimed by the authors of the book as a part of the tournament.

We rushed through our games in the tournament and finished our full quota long before any of the others, having merely entered to make up the number of players, Mr. Neumann being the only other player who played his full number of games. Each player was to play two games with every competitor, draws not to count. The winners of the most games to receive the prizes.

Two of our games have been embodied in the German Handbuch, and have been copied quite extensively on account of the pretty terminations. We also find the positions given in several publications of end games, etc. We extract them as follows from Zuckertort's collection of 1869:

LOYD AND GOLMAYO.

White.—K on K Kt sq, Q Q sq, Rs K B sq and Q R 7, Kt K B 6, Ps Q B 2, Q 3, K B 2, K Kt 2, and K R 3.
Black.—K on Q B sq, Q Q Kt 5, Rs K R sq and Q R 8, Kt Q 5, Ps Q Kt 2, Q B 2, K Kt 4 and K R 5.

White to play and win.

The game was terminated as follows:

WHITE.	BLACK.
1. R to R 8 ch	1. R x R
2. Q to K Kt 4 ch	2. K to Kt 8
3. Kt to Q 7 ch	3. K to B 8
4. Kt to Kt 6 ch	4. K to Kt 8
5. Q to B 8 ch	5. R x Q (a)
6. Kt to Q 7 ch	6. K to R 7
7. R to R sq ch	7. Q int
8. R x Q mate	

(a) Black is not compelled to capture the Queen, but there are several ways of winning the game in reply to K to R 2.

LOYD AND ROSENTHAL.

White.—K on K sq, Q K Kt 8, R Q R sq, Kts Q B 3 and 4, Ps K 3 and 4, Q 5, Q B 2, Q Kt 2 and 3.
Black.—K on Q B sq, Q Q B 2, R Q sq, Kt K sq, B K R 6, Ps K B 2, K 4, Q 3, Q B 4, Q Kt 2, and Q R 3.

White to play and win.

The following was the termination of the game

WHITE.	BLACK.
1. Kt to Q Kt 5	1. Q to K 2
2. Q to R 7	2. B to Kt 5
3. Kt to R 7 ch	3. K to Kt sq
4. R x P	4. Kt to Q B 2
5. R to R 5	5. Q to K B 3
6. Q to R sq	6. R to K R sq
7. Q to K B sq	7. B to B 6
8. Kt to Kt 6	8. Q to R 5 ch
9. K to Q 2	9. Q to Kt 5
10. Q x B	10. Q x Q, and white

mates in three moves.

As a specimen of the play of Mr. Kolisch, we select one of his games with Mr. Neumann, which is unquestionably the finest game of the Tournament.

J. Kolisch

Three prizes were offered for the best sets of six problems, three of which positions must be new, and three of which might have been already published. There were three hundred and seven problems entered, from among which the following award was made:

First Prize ....300 francs........Conrad Bayer.
Second " ....200 " ....Samuel Loyd.
Third " ....100 " .... M. Grosdemange.

Two of Bayer's masterly productions are given as regular problems, the others, which are all in five moves, we present in enigma form, as follows:

ENIGMA No. 2.—BY CONRAD BAYER.

White.—K on K Kt 4, Q Q 8, R K R 8, Bs Q B 5 and Q Kt 5, Kts K 4 and K B 2. P Q 6.
Black.—K on Q 4, Q Q Kt 2, B K B 2, Kts Q R 8, and Q Kt 6, Ps Q R 2, K 3 and 4, K Kt 4 and 6.

White to play and mate in five moves.

ENIGMA No. 3.—BY CONRAD BAYER.

White.—K on Q B 2, Q K B 5, R Q B 6, B Q B sq, Kt K 4, and K R sq, P on K Kt 2 and 5.
Black.—K on Q 5, R Q sq, Bs K 8 and K B 2, Kts K Kt 3 and K 4, Ps Q R 3 and 5, Q 2 and 4, and Q B 7.

White to play and mate in five moves.

ENIGMA No. 4.—BY CONRAD BAYER.

White.—K on K sq, Q K R 6, B Q Kt sq, Kts Q 3 and Q Kt 6, Ps K 3, K Kt 2 and K R 3.
Black.—K on K 5, Q Q B 2, R Q Kt 3, B Q 3, Kts Q B 5 and K 4, P Q R 5, Q Kt 5 and 6, Q 5, K B 2 and 5 and K Kt 6.

White to play and mate in five moves.

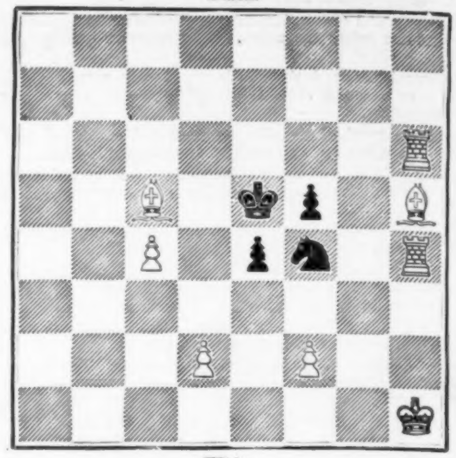
ENIGMA No. 5.—BY CONRAD BAYER.

White.—K on Q Kt sq, Q Q B 8, B on Q 5, Kt Q B 5, P Q B 4, Q 2, K B 7 and K R 2.
Black.—K on Q 5, Rs Q Kt 3 and Q 3, B K R 3, Ps Q R 2, Q Kt 5, K 4 and 6, K B 3 and 6, and K Kt 4.

White to play and mate in five moves.

PROBLEM No. 38.—By CONRAD BAYER, Olmutz, Austria. First Prize in Paris Tournoi, 1857.

Black.



White.

White to play and mate in four moves.

KOLISCH vs. NEUMANN, PARIS TOURNOI, 1868.

C. NEUMANN. WHITE.	I. KOLISCH. BLACK.
1. P to K 4	1. P to K 4
2. Kt to K B 3	2. Kt to Q B 3
3. B to Q Kt 5	3. Kt to K B 3
4. Castles.	4. B to K 2
5. Kt to Q B 3	5. P to Q 3
6. B x Kt ch	6. P x B
7. P to Q 4	7. P x P
8. Kt x P	8. B to Q 2
9. P to K B 4	9. Castles.
10. Q to Q 3	10. R to Q Kt sq
11. P to Q Kt 3	11. P to Q B4
12. Kt to K B 3	12. B to Q B 3
13. R to K sq	13. R to K sq
14. Kt to Q 5	14. Kt x Kt
15. P x Kt	15. B to K B 3
16. R x R ch	16. B x R
17. R to Kt sq	17. B to Q 2
18. B to Q 2	18. Q to Q B sq
19. R to K sq	19. B to K B 4
20. Q to Q B 4	20. Q to Q 2
21. P to Q B 3	21. R to K sq
22. P to K R 3	22. R x R ch
23. Kt x R	23. Q to K sq
24 P to K Kt 4	24. B to Q 2
25. P to Q R 4	25. P to Q B 3
26. K to B sq	26. P to K R 3
27. Q to R 6	27. P x Q P
28. Q x Q P	28. P to Q 5
29. P to Q B 4	29. B to Q B 3
30. Q x P	30. Q to K 5
31. Q to Q 6	31. B to K R 5
32. Q to Q Kt 8 ch	32. K to R 2
33. Q to K 5	33. Q to K R 8 ch
34 K to K 2	34. B to K 5
35. Q x Q P	35. P to K B 4!
36. P x P	36. Q to R 7 ch
37. K to Q sq	37. B x Kt
38. K x B	38. Q to R 8 ch
39. K to K 2 ch	39. Q to B 6 ch
40. K to R sq	40. B to K 6 and wins.

SOLUTIONS TO PROBLEMS.

No. 31.—BY R. L. C. WHITE.

WHITE.	BLACK.
1. B to K Kt sq	1. Any move.
2. Mates accordingly.	

No. 32.—BY W. A. SHINKMAN.

WHITE.	BLACK.
1. Q to Q R 7	1. K moves
2. Mates accordingly.	

Pronounced by a majority of our readers the most difficult and ingenious two mover extant.

Letter "B."—BY S. LOYD.

1. Kt to Q 2 ch	1. K to Kt 5
2. Q to R 3 ch	2. K x Q
3. R to Q Kt sq	3. Any move
4. Kt or R mates.	
	1. K x Kt
2. Q to R sq ch	2. K x P
3. R to B sq ch	3. K x Kt
4. Q to B 3 mate.	
2.	2. K to Kt 5
3. R to Kt sq ch	3. K to Kt 6
4. R x Kt mate.	
	1. K x P
2. Kt to Kt 6 ch	2. K to Q 4
3. P to B 4 ch	3. K to K 4
4. Q to R sq mate.	

How prettily philosopher Holmes brings chess in as an illustration, where "The Autocrat of the Breakfast Table" says: "The whole force of conversation depends on how much you can take for granted. Vulgar chess players have to play their games out: nothing short of the brutality of an actual checkmate satisfies their dull apprehension. But look at the masters of that noble game! White stands well enough, so far as you can see; but Red says 'mate in six moves;' White looks, nods—the game is over. Just so in talking with first-rate men, especially when they are good-natured and expansive, as they are apt to be at table."